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FLOOD PLAIN INFORMATION. GLACIER CREEK, GIRDWOOD, ALASKA.(U)
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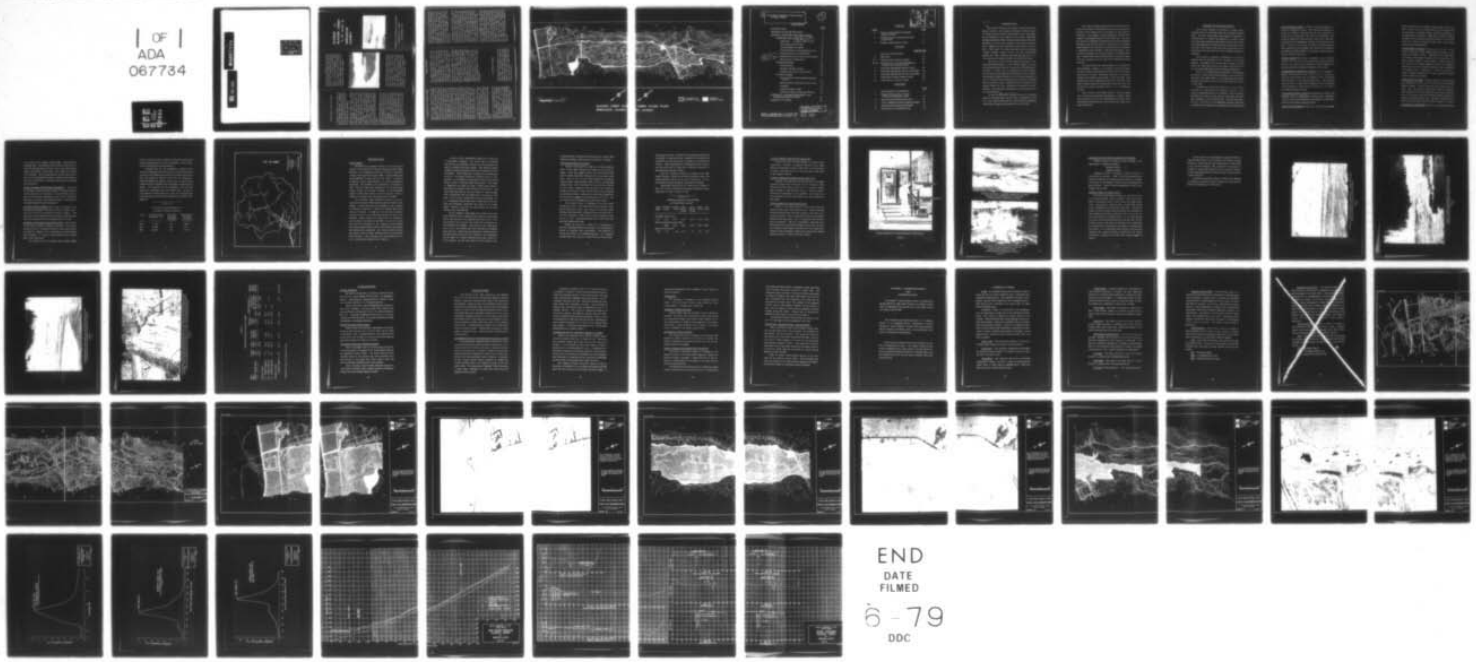

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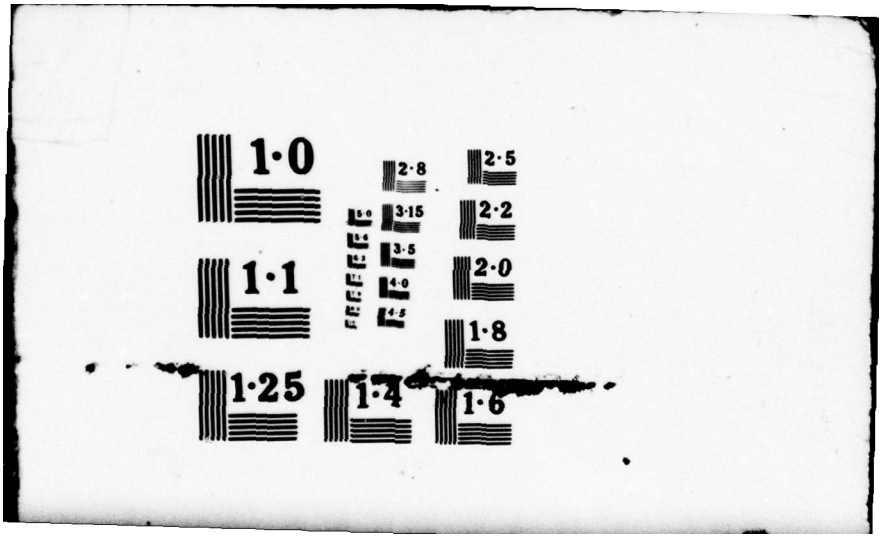
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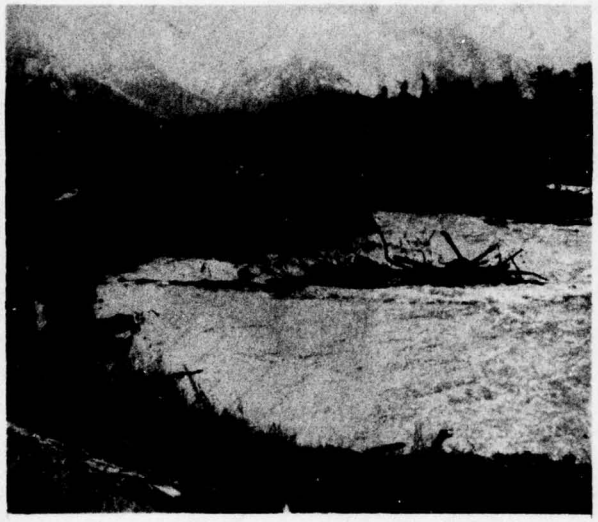
POSSIBLE SOLUTIONS

To begin a realistic program of flood damage reduction, residents must know the elevations that future floods can be expected to reach and the areas which may be flooded. These datum are available.

Although past floods have caused little damage, future floods could cause damage due to increased development of the flood plain. As economic development of this area continues, there will be even greater demand for use of land in the flood plain. Unless properly regulated, improvements in flood-prone locations would be vulnerable to serious flood damage and might restrict flood flows, causing increased flood heights and additional damage.

Flood hazard information and reasonable regulations can be used to guide and control use of flood-prone areas and thus minimize future flood damage. Such controls have been adopted in many locations and have become accepted as a practical approach to safe development and prevention of flood disasters. The adoption of flood plain regulations would not prevent the use of the area for parks or other open-type facilities.

Corrective measures may include flood-proofing to make existing and proposed structures less vulnerable. This involves permanent closure of lower openings, using flap valves on sewer openings, water-proofing walls and floors, installing removable bulkheads entrances, and other changes.



This folder has been prepared from data contained in the Corps of Engineers report entitled "Flood Plain Information, Glacier Creek, Girdwood, Alaska". Copies of the report and this folder are available from the Greater Anchorage Borough and the Department of Natural Resources, Division of Lands, State of Alaska, Anchorage, Alaska.

FLOODS *on* GLACIER CREEK *in the vicinity of* GIRDWOOD ALASKA

GREATER ANCHORAGE BOROUGH
ANCHORAGE, ALASKA
SEPTEMBER 1969

FLOODS ON GLACIER CREEK

Glacier Creek does not have the long recorded history of flooding that many Alaska streams have. However, floods have occurred on Glacier Creek since 1927 according to conversations with early settlers. This is not to say that there have not been previous floods of considerable magnitude, but rather it is an indication of the lack of records and the fact that development along its course was sparse. With the tremendous development in the Girdwood area consisting of winter sports activities the area could, and very well may, become a fully developed valley of ski slopes with related winter activities, as well as summer homes and as the development continues the flood plains are being encroached upon, and each flood will result in heavier losses.

A large flood now could seriously endanger the Girdwood area. The few businesses and homes now in the Girdwood townsite would bear the brunt of the misfortune, as well as planned developments now taking place.

This recurring damage need not happen. Data to guide safe community development, and methods for reducing future flood damage, are available. The Greater Anchorage Borough believes that citizens should be aware that floods may be expected and that damage can be greatly reduced only if precautionary measures are taken.

PAST FLOODS

The flood of September 1927 was the largest known flood of which we have knowledge on the Glacier Creek system. Other floods from intense rainstorms in the Girdwood valley are known to have occurred in the fall of 1961. There is considerable evidence of channel changes and flood levels on the trees and vegetation in the valley.

The main flood season for Glacier Creek is in the fall. Most of the floods have resulted from rainfall with a base flow. Glacier Creek is fed by numerous small glaciers at its headwaters in the Chugach Range, and these contribute to the high summer base flow. Large floods caused by intense rainfall can occur anytime during the summer or early fall; however, there is a period of high water every spring caused by the melting snows.

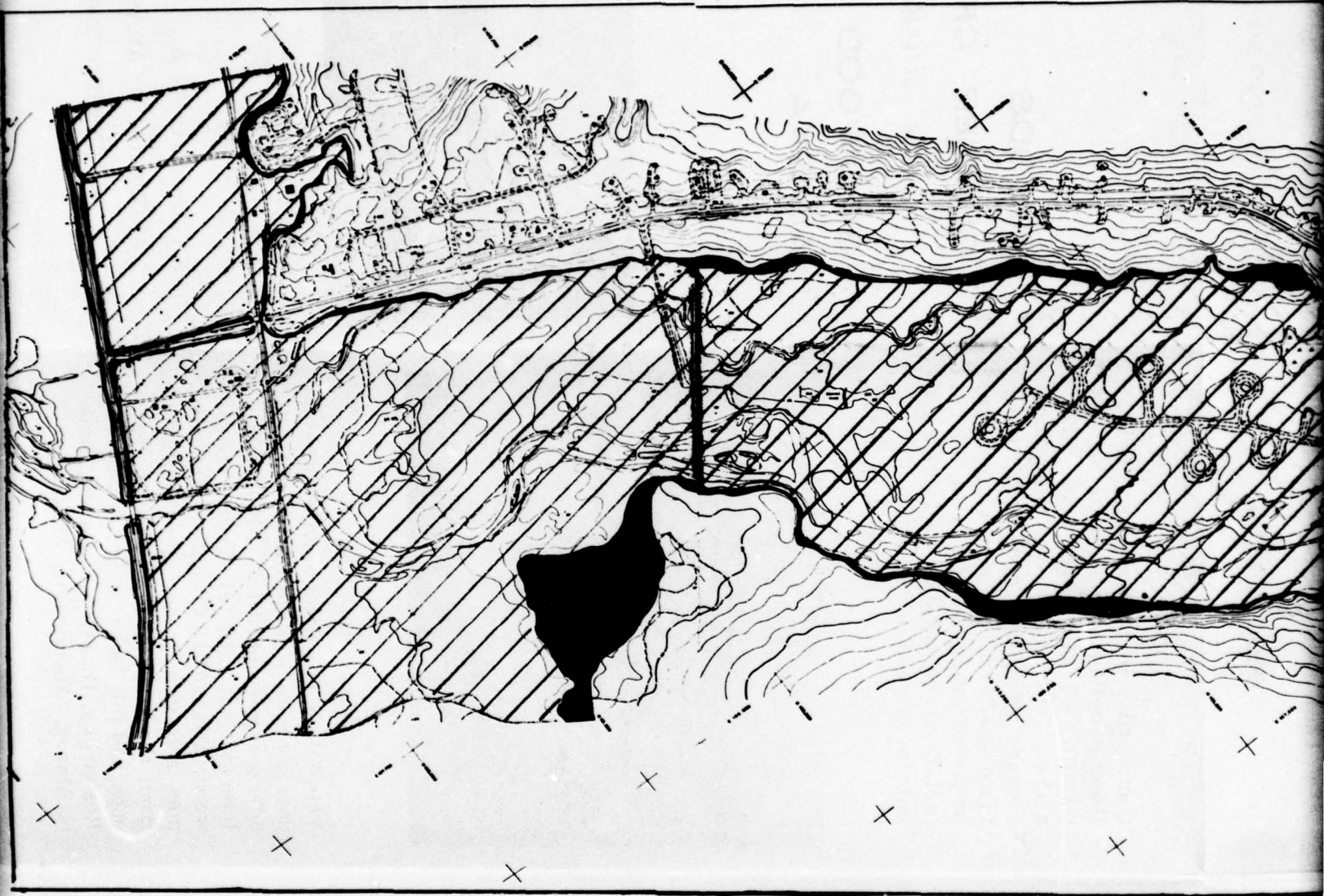
FUTURE FLOODS

Floods greater than those of record can occur. Hydrologic studies of floods and storm patterns in the Glacier Creek watershed show that future floods could be significantly more severe than those that have occurred to date.

An Intermediate Regional Flood was determined from consideration of known floods that have occurred on Glacier Creek and on similar neighboring streams. Maximum stages from an Intermediate Regional Flood, which has a frequency of occurrence of about once in 100 years on the average, would be about 3 to 4 feet higher than the 1967 flood.

A Standard Project Flood, which represents the upper limits of flooding that could result from the more severe combinations of meteorological and hydrological conditions considered reasonably characteristic of the region, has been derived from studies of storms and floods that have occurred in the Glacier Creek and adjoining watersheds. On the average the Standard Project Flood would exceed the 1967 flood height by about 6 feet.

Erosion of banks and small islands takes place with the resulting silt load building up farther downstream where there are obstructions caused by float debris. Land clearing for the airfield, various roads and subdivisions was accomplished by bulldozing all overburden directly into the stream. As a result high water with the swift currents displaces the material farther downstream and causes large jams, backing up the water and causing changes in course.



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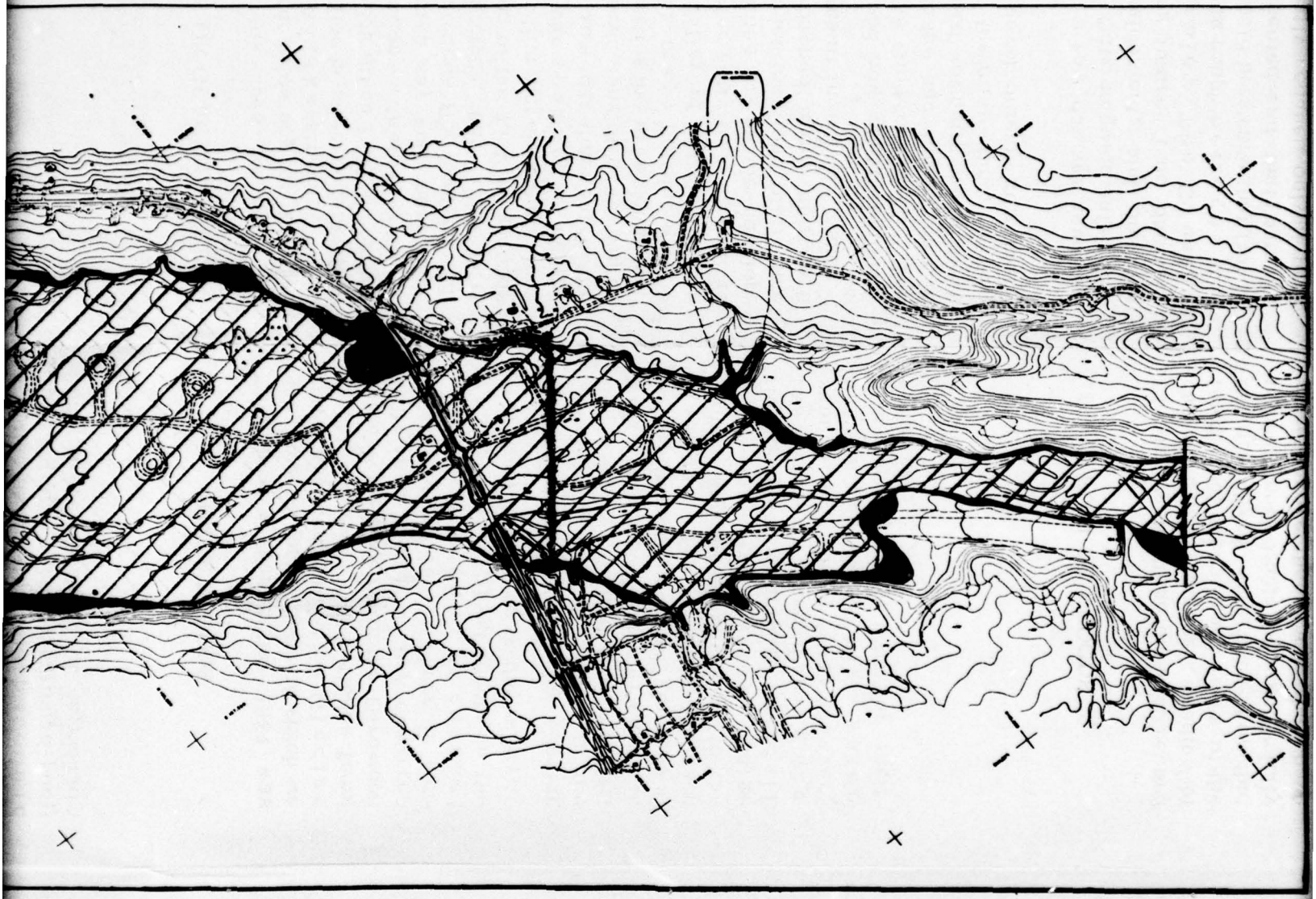
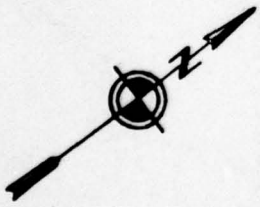
GLACIER CREEK FLO

GIRDWOOD, ALASKA





INTERMEDIATE REGIONAL FLOOD

STANDARD PROJECT FLOOD

CREEK FLOOD PLAIN

OD, ALASKA

(6) Flood Plain Information, Glacier Creek, Girdwood, Alaska.

(1)

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ABSTRACT

INTRODUCTION

This report relates to the flood situation along the Glacier Creek in the vicinity of Girdwood, Alaska, which is located about 35 miles southeasterly from Anchorage. It was prepared at the request of the Greater Anchorage Borough through the State of Alaska, Department of Natural Resources, to aid in the solution of local flood problems and to suggest the best utilization of land subject to overflow. This report is based upon information concerning rainfall, snowfall, runoff, historical and current flood heights and other technical data bearing upon the occurrence and size of potential floods in the Girdwood area.

This report covers several significant aspects of the potential flood problems. It first brings together a record of the largest known floods of the past in the Girdwood area. Secondly, it deals with the probability of future floods, such as Intermediate Regional and Standard Project Floods. Intermediate Regional Floods have an average frequency of once in 100 years as determined from an analysis of known floods on Glacier Creek. Standard Project Floods are the largest floods that may reasonably be expected to occur. However, they should be considered in the planning for use of the flood plains.

ABSTRACT

In view of the need to control the use of the flood plains of Girdwood and to guide future development in the area, this study develops the size and frequency of both the Intermediate Regional and Standard Project Floods.

The report contains maps and cross-sections which indicate the extent of flooding which has been experienced and that which might occur in the future in the vicinity of Girdwood. The graphic map presentation should prove helpful in planning the best use of the flood plain. By using the report it is possible to determine the depth of probable flooding in any location, either by recurrence of the largest known floods or by occurrence of the Intermediate Regional or Standard Project Floods. With this information, floor levels for buildings may be planned high to avoid flood damage. Construction below predicted flood elevations is done with full recognition of the risks and of flooding hazards involved.

This report does not include plans for the solution of flood problems. Rather, it is intended to provide the basis for future study and planning on the part of the City of Girdwood and the Greater Anchorage Borough in arriving at solutions to minimize vulnerability to flood damage. This might involve local planning to control the use of the flood plain through zoning and subdivision regulations, the construction of flood protection works, or a combination thereof.

Upon request, The Alaska District, Corps of Engineers, will provide technical assistance to Federal, State, and local agencies in the interpretation and use of the information contained herein and will provide other available related data.

SUMMARY OF FLOOD SITUATION

The present townsite of Girdwood is largely underdeveloped since its relocation after the earthquake of March 1964. The area immediately surrounding the townsite in the flood plain is rapidly developing into a winter resort area with many expensive chalet type structures as a result of the development and expansion of the Alyeska Ski recreation area. This report covers the area along Glacier Creek flood plains from the north end of the Girdwood airstrip to tidewater.

The principal residential development at this time extends from the foothills of Mt. Alyeska to the Seward Highway. The higher areas have been developed, while the area in the flood plain and on the banks of Glacier Creek are now being subdivided and development taking place.

The U. S. Geological Survey maintains a stream gage on Glacier Creek at the railroad bridge, which has been in operation since August 1965. A crest stage gage was established on California Creek at the Alyeska Highway culvert in June 1968.

Residents were interviewed and historical documents searched for information concerning past floods. From these investigations and from theoretical studies of possible floods on Glacier Creek and its tributaries, the local flood situation, has been developed. The following paragraphs summarize the significant findings, which are discussed in more detail in succeeding sections of this report.

THE GREATEST FLOOD of which we have knowledge occurred in September of 1927. This flood was probably the result of rainfall: 6.48 inches of rain was measured in Cordova on the 18th and 1.50 inches in Anchorage, 1.83 inches at Kennecott; and excessive values were generally measured at all southcentral stations in operation at that time. This indicates that the storm was quite general. Wind records are not available, but excessive precipitation at Kodiak and other stations to the south indicate that the storm came from the south.

OTHER FLOODS from intense rainstorms in the Girdwood valley are known to have occurred in the fall of 1961. There is considerable evidence of channel changes and flood levels on the trees and vegetation in the valley.

INTERMEDIATE REGIONAL FLOODS have an average frequency of occurrence in the order of once in 100 years. They are determined from an analysis of this stream and other streams in the same general area. The analysis indicates that the Intermediate Regional Flood for Glacier Creek would have a water surface elevation of 111.7 feet at the Alyeska Highway Bridge.

STANDARD PROJECT FLOOD determinations indicate that flooding, under a combination of most severe conditions, would occur in the Girdwood area at a depth of 2 feet higher than the Intermediate Regional Flood.

MAIN FLOOD SEASON for Glacier Creek is in the fall.

Most of the floods have resulted from rainfall with a base flow. Glacier Creek is fed by numerous small glaciers at its headwaters in Chugach Range, and these contribute to the high summer base flow. Large floods caused by intense rainfall can occur anytime during the summer or early fall; however, there is a period of high water every spring caused by the melting snows.

VELOCITIES OF WATER during major floods range up to 15 feet per second (about 10 miles per hour) in the channel of Glacier Creek. Velocities on the flood plain vary widely, depending on location, but are generally less than 5 feet per second. During floods, current directions and velocities can change rapidly as a result of changes in conditions; thus main channel velocities could be attained in overbank areas. Velocities of 3 feet per second or greater combined with depths of 3 feet or greater are generally considered hazardous.

DURATION OF FLOODS: During a flood, the stream would rise rapidly to an elevation of 105 feet at the Alyeska Highway Bridge, at which stage the creek would go overbank. Any rise above that elevation would be relatively slow because of the relief afforded by the large overbank area. Consequently any rise above 106 feet would normally be at a much slower rate. The IRF would be out of banks for about 2 days, and the SPF for about 2-1/2 days.

HAZARDOUS CONDITIONS would occur during large floods

as a result of the rapidly rising stream, high velocities and deep flows. An additional hazard during a flood is presented by floating logs and trees, which can destroy buildings or cause jams, erode banks, and change the location of the channel. This floating debris can also pile up overbank in an unpredictable manner, causing rapid shifts in direction of waterflow, velocities and increase in predicted water surfaces.

FLOOD DAMAGE PREVENTION MEASURES. There are no existing or authorized flood control or related measures in the study area or upstream in the watershed; nor are there any flood plain regulations in the City of Girdwood. However, the Greater Anchorage Borough is in the process of establishing flood plain regulations.

FUTURE FLOOD HEIGHTS that would be reached if the Intermediate Regional and Standard Project Floods occurred in the vicinity of Girdwood are shown in Table 1. The table gives the comparison of these flood crests and also shows the comparison with the highest flood of record.

GENERAL CONDITIONS AND PAST FLOODS. This section of the report includes a general description of the study area and a history of floods on Glacier Creek in the vicinity of Girdwood, together with a discussion of the prevailing flood situation. It covers in detail obstructions to flood flows in the study area.

The portion of the Girdwood study extends along

Glacier Creek from the Girdwood or Alyeska airstrip down stream approximately 3 miles to tidewater, which is generally considered the Seward Highway.

Although there are few newspaper accounts or other records of flooding in the flood plain, persons interviewed recall several seasons when areas were flooded during the fall rain season in Glacier Creek and its tributaries. Potential floods from Glacier Creek in the vicinity of Girdwood have been developed from the meager records of past floods. The possible area of inundation, used for this report was developed from the earlier data, as well as from reports of flood observers in the area during heavy runoff periods and from field investigations and office computations.

TABLE 1

RELATIVE FLOOD HEIGHTS AT
ALYESKA HIGHWAY BRIDGE

Flood	Estimated Peak Discharge (cfs)	Streambed Elevation (feet MSL)	Watersurface Elevation (feet MSL)
1967	7,710	101	108.0
IRF	14,000	101	111.7
SPF	26,000	101	114.0

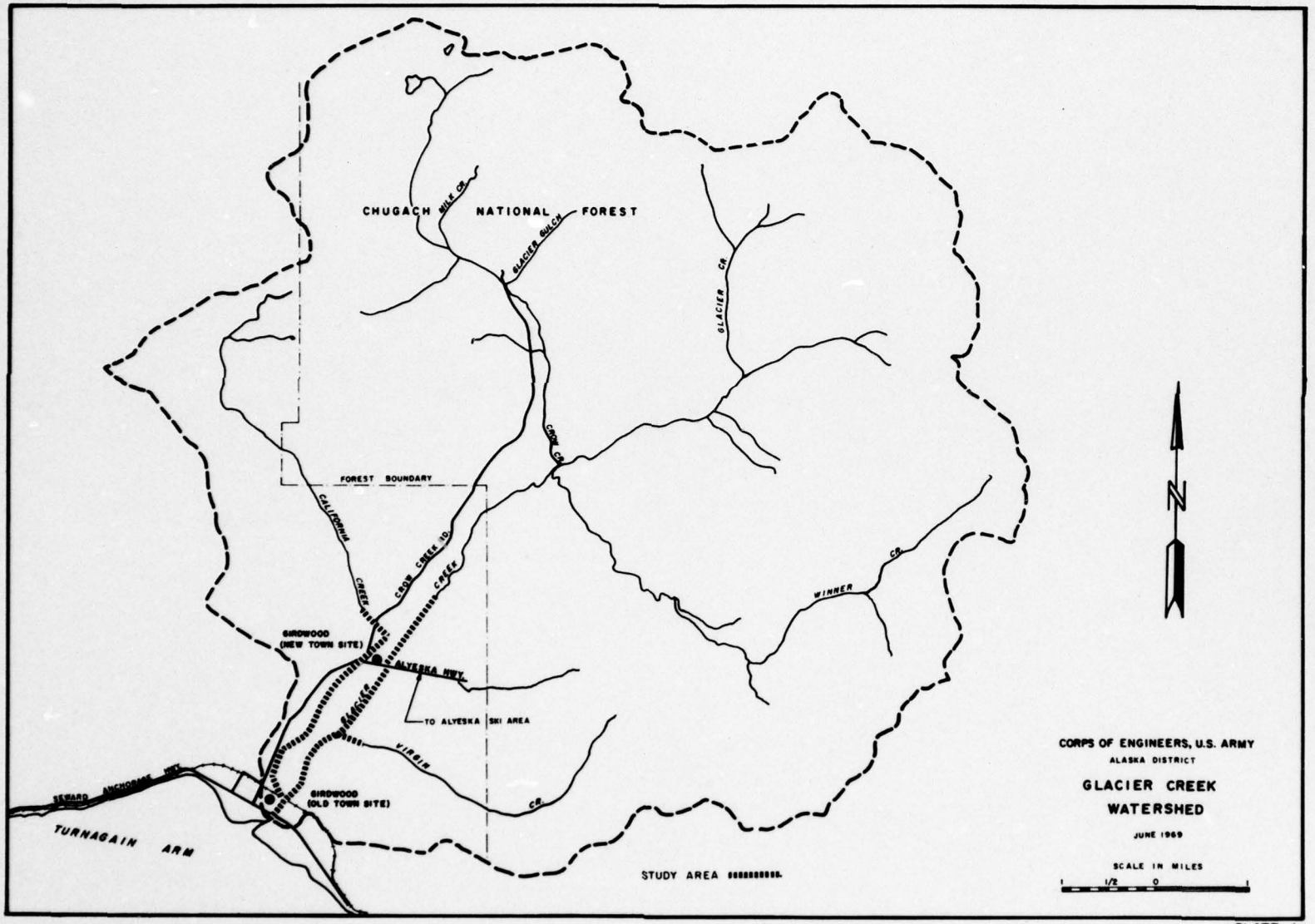

CHUGACH NATIONAL FOREST
MILE CR.
GLACIER GULCH
GLACIER CR.
CARK CR.
FOREST BOUNDARY
CALIFORNIA CREEK
CROW CREEK TO CROW CREEK
WINNER CR.
GIRDWOOD (NEW TOWN SITE)
ALYESKA HWY.
TO ALYESKA SKI AREA
VIRGIN CR.
SEWARD ANCHORAGE HWY.
GIRDWOOD (OLD TOWN SITE)
TURNAGAIN ARM
STUDY AREA
N
CORPS OF ENGINEERS, U.S. ARMY
ALASKA DISTRICT
GLACIER CREEK
WATERSHED
JUNE 1969
SCALE IN MILES
1 1/2 0 1

PLATE 1

GIRDWOOD AREA

SETTLEMENT:

Girdwood was originally located on the lower end of Glacier Creek between the Seward Highway and the Alaska Railroad. The village was named for James E. Girdwood, a miner who came to the area in 1896. A gold mining camp was established in about 1898 on Crow Creek, a tributary to Glacier Creek, approximately 5.5 miles northeast of Girdwood. The postoffice was established in Girdwood in 1907. Glacier Creek near Girdwood is one of thirty seven Glacier Creeks in the State of Alaska. It was reportedly named in 1898 which makes it the first Glacier Creek in Alaska as all others were not named until the 1900's.

The Girdwood valley became of interest to the ski enthusiast in the mid 1950's and was eyed for future development. A small ski slope was developed on Mt. Alyeska in 1956 with a rope tow, in 1957-8 the Alyeska Ski Corporation was formed. A lodge and chair lift were constructed and a subdivision was laid out near the foot of the mountain. Many chalets were constructed by individuals, some of which are valued at $20,000. Soon the area along the road from Girdwood to Mt. Alyeska became spotted with cabins and permanent homes, sub-dividing and building has continued at a rapid pace. Mt. Alyeska became nationally known, and the Junior National Ski Races were held there one year. Other national and international skiers have traversed the slopes of Mt. Alyeska.

In March 1964, southcentral Alaska was rocked with a tremendous earthquake. The major effect at Girdwood was that the area subsided several feet thus allowing tidewater to inundate the small village. The Seward Highway leading to and from Girdwood was severly damaged as were all bridges. When things quit rocking and reconstruction started, the people decided to relocate nearer to Mt. Alyeska. In so doing an area between California Creek and Glacier Creek in the flood plain was selected. The Corps of Engineers was asked to make a preliminary study to determine the possible flood hazard of the new site. The study indicated that the area was subject to flood damage and recommended that the village not be relocated in that area. Prior to the construction of the new highway, the U. S. Geological Survey also made a flood study of the new town and essentially confirmed the results of the Corps study. However, the area was sub-divided by the state and lots were auctioned off.

As the highways and bridges were rebuilt and a new hard surfaced road to Alyeska was constructed, the people had a new interest in the Alyeska Ski Resort area. The new townsite has received very little interest because of the possibility of flooding. Other areas in the flood plain have been sub-divided and more development is taking place each day. Major new development by Alaska Airlines has taken place at the foot of Mt. Alyeska, more is planned and the plans for a major nationally known ski resort are in the making. By the same token the flood plains in the

Girdwood valley is being encroached upon with major flood damage in making, unless proper precautions are taken.

THE STREAM AND ITS VALLEY:

Glacier Creek heads in a glacier on Goat Mountain, which is over 6000 elevation and located in the Chugach Range. From this rugged terrain, the creek flows south until it enters Girdwood Valley where it then flows southwest. As Glacier Creek flows through the relatively narrow valley, other streams enter from the surrounding rough terrain. Crow Creek flows in from the west, Winner Creek is next coming in from the east, then California Creek from the west, Virgin Creek from the east, followed by numerous smaller creeks that are normally insignificant but can become ragging torrents during a heavy rain. The area of the entire drainage basin is 62 square miles.

The primary cause of flooding is the rapid runoff during heavy rains. The most severe flood known to date, which occurred in 1927, was observed by Mr. Arnie Erikson who stated that in addition to the continued four-or five-day downpour a snow slide occurred upstream from Crow Creek. The slide emptied into a small lake and pratically emptied the lake.

Floods can occur as a result of a combination of factors, including amount of snow pack, air temperatures, amount of sunshine and precipitation. The sequence of events also affects the flooding potential. For example, spring floods may occur as a result of above normal snow-

fall during the winter, followed by an unusually cold spring, and finally, a rapid snow melt. Summer or full floods can result from an extreme amount of rainfall in a short period of time. High temperatures in the glacial areas or warm rain on snow and ice fields will contribute somewhat to flooding during summer months.

The new Girdwood townsite is located on the right bank of Glacier Creek, to the left of California Creek, and on the upstream side of the Alyeska Highway. It is a picturesque location but highly vulnerable to flooding.

Most known floods have not caused great damage to date, but with the continued development taking place in the flood plain it is just a matter of time.

TABLE 2

DRAINAGE AREAS IN WATERSHED OF GIRDWOOD VALLEY

Total Basin	California Creek	Winner Creek	Upper Glacier Creek	Lower Glacier Creek	Virgin Creek	Crow Creek
Drainage Area (sq mi)						
62.0	8.90	12.67	15.01	8.04	4.70	12.65
Maximum Elevation (feet MSL)						
	6380	5215	4900	3039	4235	6380
Glacier Area (sq mi)						
5.07	.21	.56	2.75	.11	.07	1.37

FLOOD DAMAGE PREVENTION MEASURES:

There have been no flood damage prevention works constructed. However, emergency measures were taken after the earthquake of March 1964 when it was necessary to build a sand bag dike for protection against high tides at the original townsite.

FLOOD WARNING OR FORECASTING SERVICES:

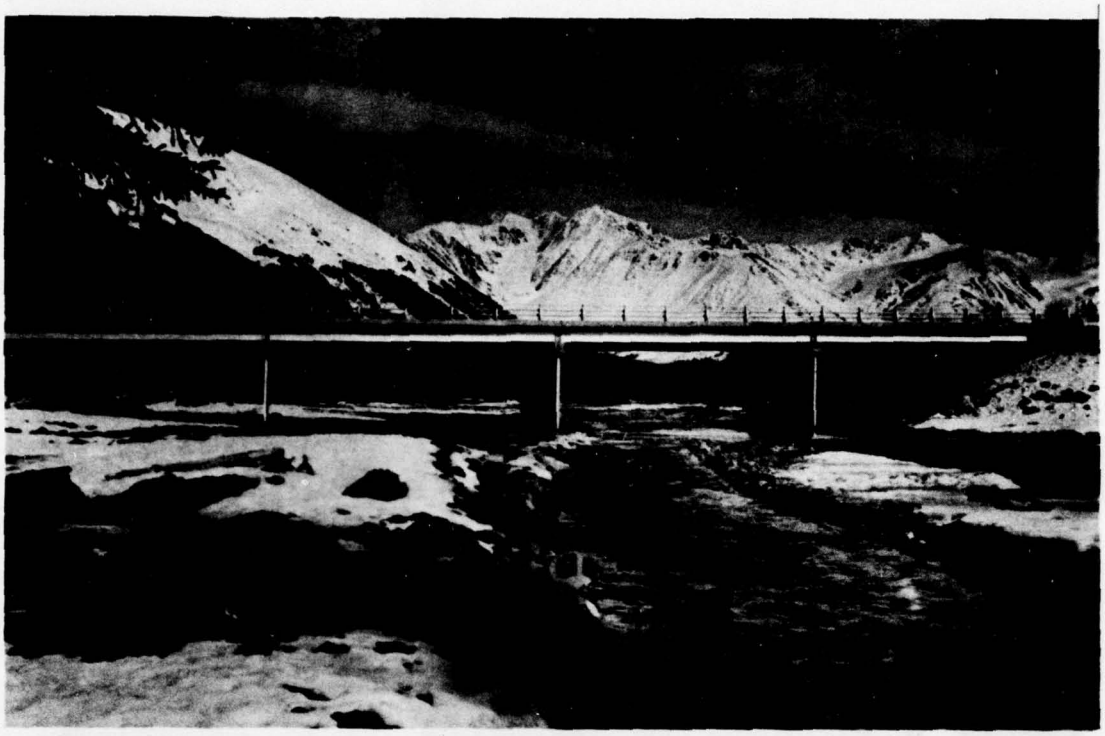
Specific creek forecasts are not feasible for drainage areas as small as that of Glacier Creek. However, flood advisories will be issued from the U. S. Weather Bureau when rainfall of high intensity occurs. General weather forecasts of temperatures, precipitation, and cloud cover are broadcast several times daily over radio stations in Anchorage.

DEVELOPMENT IN THE FLOOD PLAIN:

Plate 2 is an index map of 3 sheets that show the potential flood area of the Girdwood area. Plates 3 through 5 show the flood plain of Glacier Creek for the reach covered by this report. There is limited development existing at present in the flood plain, but it is apparent that development is proposed. The area immediately upstream from the report area is sparsely developed at this time, but with the continued winter sports activities the area could later become a fully developed valley of ski slopes with related winter activities, as well as summer homes.

FLOOD HEIGHTS AT THE GIRDWOOD POSTOFFICE

Figure 1



BRIDGE CROSSING GLACIER CREEK ON ALYESKA HIGHWAY WAS DESIGNED TO PASS THE INTERMEDIATE REGIONAL FLOOD

TWO 72 INCH CULVERTS ON CALIFORNIA CREEK CROSSING ALYESKA HIGHWAY. NOT OF SUFFICIENT SIZE TO CARRY INTERMEDIATE REGIONAL FLOOD

Figure 2

BRIDGES AND CULVERTS ACROSS THE STREAMS:

Glacier Creek is crossed by three bridges in the study reach, classified as follows:

Railroad Bridge - 1

Highway Bridges - 2

California Creek, a tributary to Glacier Creek, is crossed by two culverts. Table 3 lists the pertinent elevations and locations for these structures and their relation to the crest of the Standard Project and Intermediate Regional Floods. Figure 2 shows photographs of some of the bridges and culverts.

OBSTRUCTIONS TO FLOOD FLOW:

The major obstructions to flood flow on Glacier Creek are the small islands, sharp meanders, silt load and the debris consisting of brush, small spruce and large cottonwood. During heavy runoff periods, considerable change in the configuration of the stream takes place. Erosion of banks and small islands takes place with the resulting silt load building up further downstream where there are obstructions caused by floating debris. It was noted during the course of this study that the land clearing done for the airfield, various roads and sub-divisions was accomplished by bulldozing all overburden on the banks or directly into the stream. As a result high water with the swift currents displaces this material farther downstream and causes large jams, backing up the water and causing changes in course.

In the event of an Intermediate Regional Flood the logs and other debris in the creekbed from natural erosion upstream, coupled with the man-caused debris, could create a very serious situation. The occurrence of log jams at bridges or large jams along the main channel of Glacier Creek would appreciably increase the water surface profile shown on Plate 9.

Local action should be taken to prohibit the dumping or dozing of overburden into the stream and to prevent any future encroachments or restrictions.

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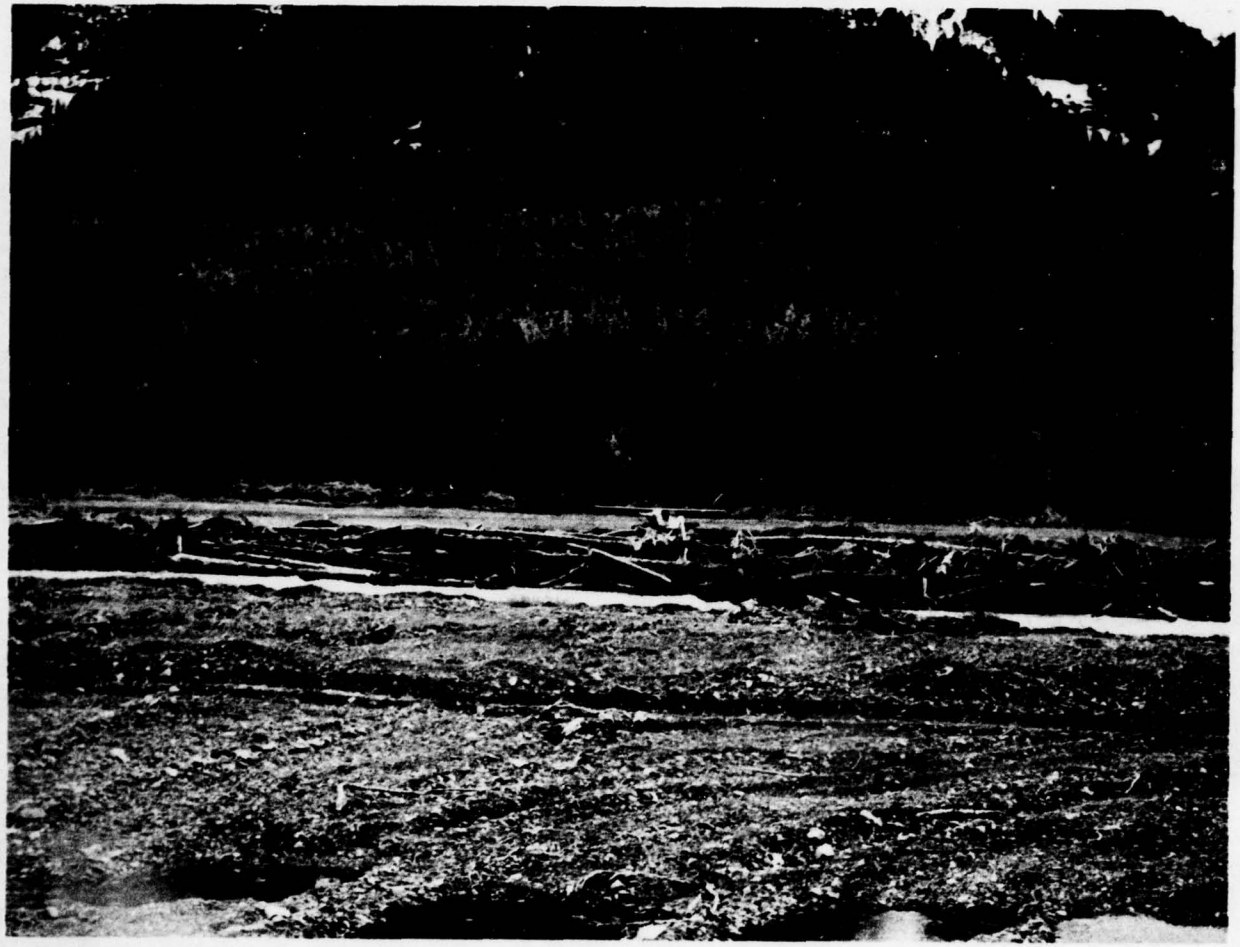

TYPICAL LAND CLEARING IN THE AREA. STRIP THE LAND AND BULLDOZE IT INTO GLACIER CREEK.

Figure 3

TREES, STUMPS AND BRUSH CLOG THE STREAM
WHICH STARTS EROSION AND CHANNEL CHANGES

Figure 4

APPROXIMATELY 500 FEET OF THE SOUTH END OF THE GIRDWOOD RUNWAY ERODED DURING 1967 FLOOD

Figure 5

COTTONWOOD TREE WITH ROOTS GROWING OUT OF TRUNK TEN FEET ABOVE BASE OF TREE. PAST YEARS SILT HAD BUILT UP SO THE TREE PRODUCED NEW ROOTS THE 1967 FLOOD ERODED THE BUILD UP BACK TO THE ORIGINAL BASE.

Figure 6

TABLE 3

BRIDGES ACROSS GLACIER CREEK

Mile Above Mouth	Identification	Stream Bed Elev.	Road Surface Elev.	Intermed. Regional Flood Cr.	Standard Project Flood Crest	Underclearance			Number Size & Kind of Culvert
						Elev.	Relation to Int. Reg. Flood Above-	Below-	
		Feet	Feet			Feet	Feet	Feet	
Glacier Creek									
0.4	Seward Highway	12	30.4	25.0	27.0	26.1	1.1		
0.6	Alaska Railroad	18	26.0	28.7	30.0	23.0		5.7	
2.6	Alyeska Highway	101	118.8	111.7	114.0	115.0	3.3		
California Creek									
	* Alyeska Highway	103	116.0	111.7	114.0	103.4		8.3	2-42"x72"

* Adjacent to mile 2.6 on Glacier Creek

FLOOD SITUATION

FLOOD RECORDS:

Records of stream flows on Glacier Creek have been maintained since August 1965 by the U. S. Geological Survey. Miscellaneous measurements of Glacier Creek are available from the U. S. Geological Survey.

These records have been supplemented by interviews with local residents, recovered high water marks from previous floods, and tide data from U. S. Coast & Geodetic Survey. Using the foregoing records and correlating weather records with flows, it has been possible to develop a knowledge of flooding at Girdwood.

DURATION AND RATE OF RISE:

Plate 6 shows the discharge hydrograph for Glacier Creek at the Alaska Railroad Bridge for the flood of September 1967. During this flood, the creek rose at a maximum rate of about 0.3 feet per hour and remained above flood stage of 6.2 feet for 27 hours.

FLOODED AREAS AND CROSS-SECTIONS:

Plates 3 through 5 show the areas along the Glacier Creek that would be inundated by the Intermediate Regional and Standard Project Floods. The actual limits of these overflow areas on the ground may vary somewhat from those shown on the maps since their scale is such that precise plotting of flooded areas is not possible.

Plate 10 shows cross-sections obtained during surveys made in 1969 with water surface elevations of Standard Project and Intermediate Regional Floods.

FUTURE FLOODS

This section of the report discusses the Standard Project Flood and the Intermediate Regional Flood on Glacier Creek near Girdwood and some of the hazards of great floods. Floods the size of the Standard Project Flood represent the reasonable upper limits of expected flooding. Those the size of the Intermediate Regional Flood represent floods that may reasonably be expected to occur more frequently, although they will not be as high as the Standard Project Flood. While they have not been known to occur there is reason to suspect that they could occur sometime in the future. In determining the floods that would result from this type of storm, consideration was given to topography, watershed cover, and the physical characteristics of the stream.

DETERMINATION OF INTERMEDIATE REGIONAL FLOOD

The Intermediate Regional Flood is defined as a flood at any given location having an average frequency of occurrence in the order of once in 100 years, although the flood may occur in any year. Frequency estimates are generally based on statistical analyses of stream flow records available for the watershed under study. However, limitations in such records usually require analyses of rainfall and runoff characteristics in the "general region" of the area under study. The Intermediate Regional Flood represents a major flood, although it is much less severe than the Standard Project Flood.

Streamflow records of the U. S. Geological Survey at stations on Glacier Creek and miscellaneous measurements on portions of Glacier Creek were used in deriving at the Intermediate Regional Flood at Girdwood. The precipitation amounts with their specified frequencies were used along with streamflow records. The precipitation amounts and temperature date are published by the U. S. Weather Bureau. The results of statistical analysis and electronic computer correlations indicate that the Intermediate Regional Flood peak discharge for Glacier Creek at Girdwood is 14,000 cubic feet per second, resulting in a water surface elevation of 111.7 feet at the Alyeska Highway Bridge. A discharge hydrograph of the Intermediate Regional Flood is shown in Plate 7.

DETERMINATION OF STANDARD PROJECT FLOODS

Only in rare instances has a specific stream experienced the largest flood that is likely to occur. Severe as the maximum known flood may have been on any given stream, it is commonly accepted that sooner or later a larger flood can and probably will occur. A Standard Project Flood is defined as the largest flood that can be experienced from the most severe combination of meteorological and hydrological conditions that are considered reasonably characteristic of the geographical region involved.

The Standard Project Flood for Glacier Creek at Girdwood is estimated to have a peak discharge of 26,000 cubic feet per second at the Alyeska Railroad Bridge. A

discharge hydrograph of the Standard Project Floods is shown on Plate 8.

FREQUENCY:

No frequency is assigned to the Standard Project Flood. The occurrence of such a flood would be a rare event; however, it could occur in any year.

POSSIBLE LARGER FLOODS:

Floods larger than the Standard Project Flood are possible. However, the combination of factors that would be necessary to produce such floods would seldom occur. The consideration of floods of this magnitude is of greater importance in some problems than in others, but should not be overlooked in the study of any problem.

HAZARDS OF GREAT FLOODS:

The amount and extent of damage caused by any flood depends in general upon how much area is flooded, the height of flooding, the velocities of flow, the rate of rise, and the duration of flooding.

AREAS FLOODED AND HEIGHTS OF FLOODING:

The areas of Girdwood subject to flooding by the Standard Project and Intermediate Regional Floods are shown on Plates 3 through 5. Depth's of flow can be obtained by subtracting the elevation at the point desired from the flood elevation.

The profiles for the streams were computed by using stream characteristics for selected reaches as determined

from observed flood profiles, topographic maps, and valley cross sections which were surveyed in April 1969. The elevations shown on Plate 2 and the overflow areas shown on Plates 3 through 5 have been determined with an accuracy consistent with the purposes of this study and the accuracy of the basic data. The profiles of the Standard Project and the Intermediate Regional Floods depend in part upon the degree of destruction or clogging of various bridges during the flood. Bridges that are particularly affected by these flows are discussed on Page 11.

The Standard Project Flood profile for Glacier Creek is 3 to 7 feet higher than the September 1967 flood.

VELOCITIES, RATES OF RISE, AND DURATION:

Water velocities during a flood depend largely upon the size and shape of the cross-sections, the conditions of the stream, and the bed slope. The maximum velocities that would occur in the main channel and overbank areas at Girdwood would range up to 15 feet per second during Intermediate Regional Floods. The maximum velocities that would occur in the main channel and overbank areas at Girdwood would range up to 20 feet per second during Standard Project Floods.

Plate 10 shows cross-sections typical of the ones used for the Glacier Creek study. The elevations and extent of overflow of the Intermediate Regional and Standard Project Floods are indicated on these sections.

AUTHORITY, ACKNOWLEDGEMENTS, AND INTERPRETATIONS

This report has been prepared under the authority of Section 206 of the 1960 Flood Control Act (Public Law 86-645), as amended by Section 206 of the 1966 Flood Control Act (Public Law 89-789).

* * *

The assistance and cooperation of the U. S. Weather Bureau, U. S. Geological Survey, Department of Natural Resources, State of Alaska, Greater Anchorage Borough, and the village of Girdwood aided in the preparation of the report are gratefully acknowledged.

* * *

This report presents the local flood situation for the City of Girdwood and vicinity. The Alaska District of the Corps of Engineers will, upon request, provide interpretation and limited technical assistance to Federal, State, and local agencies and will provide other available flood data related thereto.

GLOSSARY OF TERMS

Flood. An overflow of lands not normally covered by water and that are used or usable by man. Floods have two essential characteristics: The inundation of land is temporary; and the land is adjacent to and inundated by overflow from a river or stream or an ocean, lake, or other body of standing water.

Normally a "flood" is considered as any temporary rise in stream flow or stage, but not the ponding of surface water, that results in significant adverse effects in the vicinity. Adverse effects may include damages from overflow of land areas, temporary backwater effects in sewers and local drainage channels, creation of unsanitary conditions or other unfavorable situations by deposition of materials in stream channels during flood recessions, rise of ground water coincident with increased stream flow, and other problems.

Flood Crest. The maximum stage or elevation reached by the waters of a flood at a given location.

Flood Peak. The maximum instantaneous discharge of a flood at a given location. It usually occurs at or near the time of the flood crest.

Flood Plain. The relatively flat area or low lands adjoining the channel of a river, stream or watercourse or ocean, lake, or other body of standing water, which has been or may be covered by flood water.

Flood Profile. A graph showing the relationship of water surface elevation to location, the later generally expressed as distance above mouth for a stream of water flowing in an open channel. It is generally drawn to show surface elevation for the crest of a specific flood, but may be prepared for conditions at a given time or stage.

Flood Stage. The stage or elevation at which overflow of the natural banks of a stream or body of water begins in the reach or area in which the elevation is measured.

Head Loss. The effect of obstructions, such as narrow bridge openings or buildings that limit the area through which water must flow, raising the surface of the water upstream from the obstruction.

Intermediate Regional Flood. A flood having an average frequency of occurrence in the order of once in 100 years although the flood may occur in any year. It is based on statistical analyses of streamflow records available for the watershed and analyses of rainfall and runoff characteristics in the "general region of the watershed".

Left Bank. The bank on the left side of a river, stream, or watercourse, looking downstream.

Right Bank. The bank on the right side of a river, stream, or watercourse, looking downstream.

Low Steel (Underclearance). See "underclearance".

Standard Project Flood. The flood that may be expected from the most severe combination of meteorological and hydrological conditions that is considered reasonably characteristic of the geographical area in which the drainage basin is located, excluding extremely rare combinations. Peak discharges for these floods are generally about 40% or 60% of the Probable Maximum Floods for the same basins. Such floods, as used by the Corps of Engineers, are intended as practicable expressions of the degree of protection that should be sought in the design of flood control works, the failure of which might be disastrous.

Underclearance. The lowest point of a bridge or other structure over or across a river, stream, or watercourse that limits the opening through which water flows. This is referred to as "low steel" in some regions.

CFS. Cubic Foot per Second is the rate of discharge of a stream whose channel is one square foot in cross-sectional area and whose average velocity is one foot per second.

CM. Corrugated Metal.

CMP. Corrugated Metal Pipe.

RCP. Reinforced Concrete Pipe.

Standard Project Flood. The flood that may be expected from the most severe combination of meteorological and hydrological conditions that is considered reasonably characteristic of the geographical area in which the drainage basin is located, excluding extreme or rare combinations. Peak discharges for these floods are generally about 40% or 60% of the Probable Maximum Floods for the same basins. Such floods, as used by the Corps of Engineers, are intended as practical expressions of the degree of protection that should be sought in the design of flood control works, the failure of which might be disastrous.

Underclearance. The lowest point of a bridge or other structure over or across a river, stream, or watercourse that limits the opening through which water flows. This is referred to as low steel in some regions.

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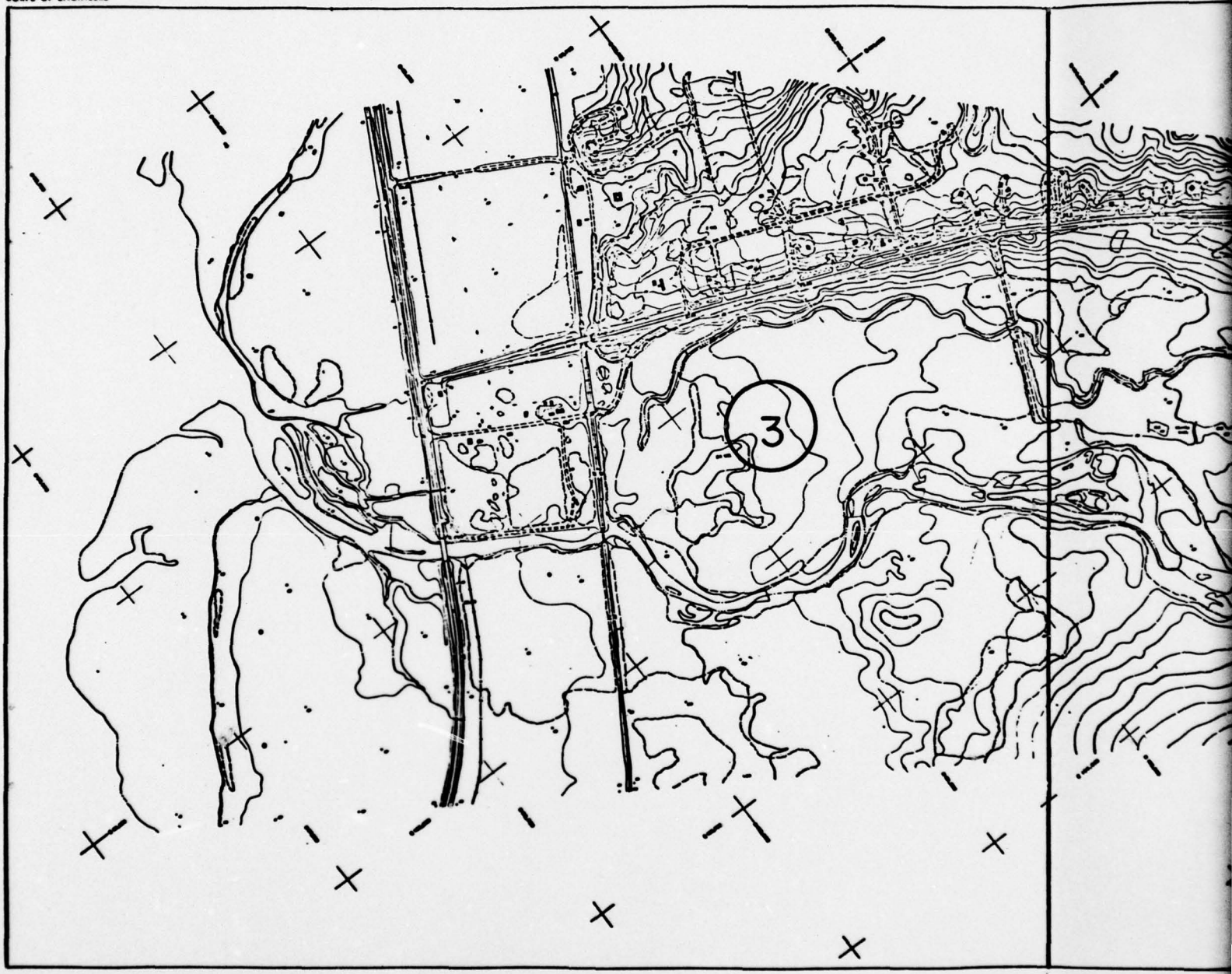
CORPS OF ENGINEERS



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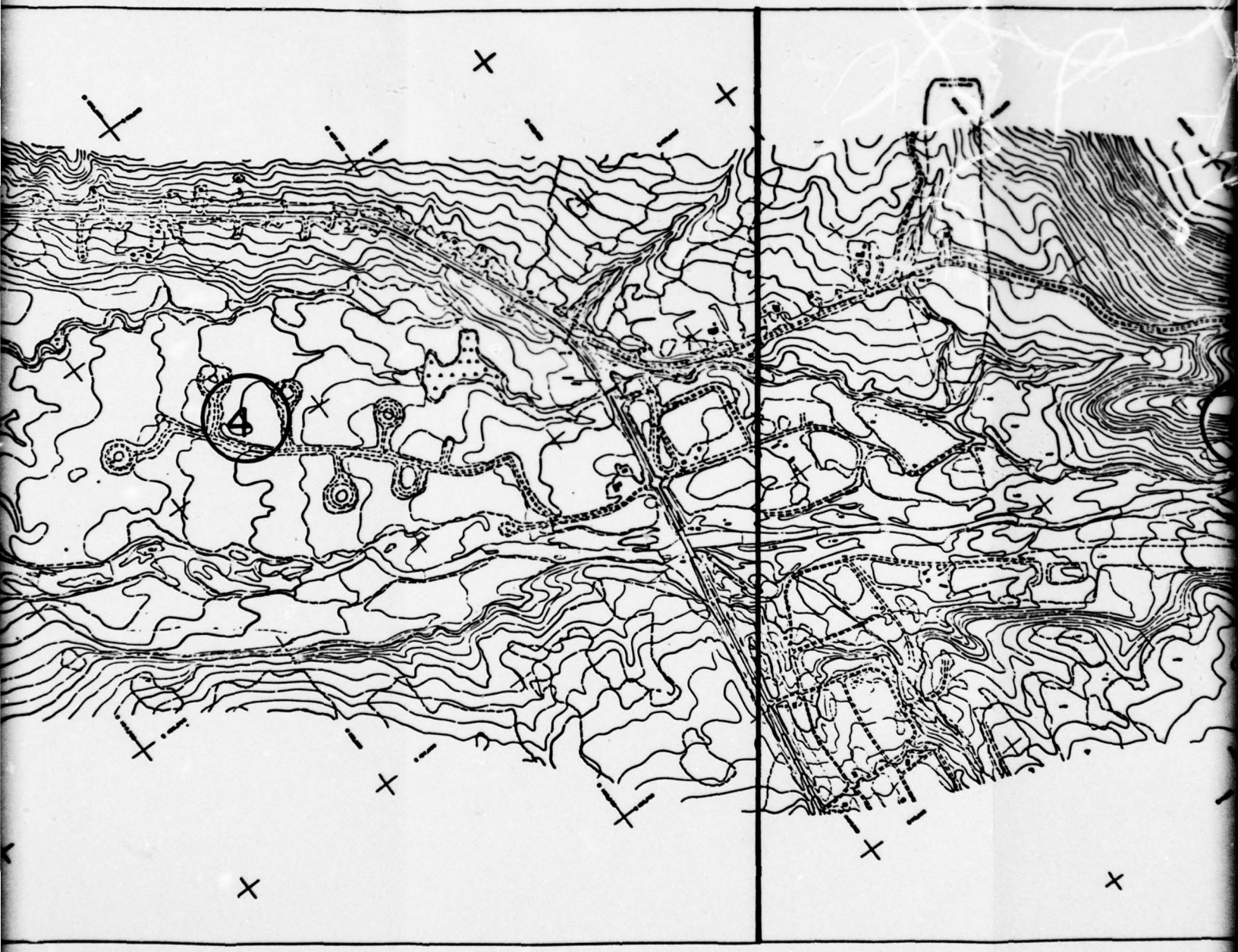
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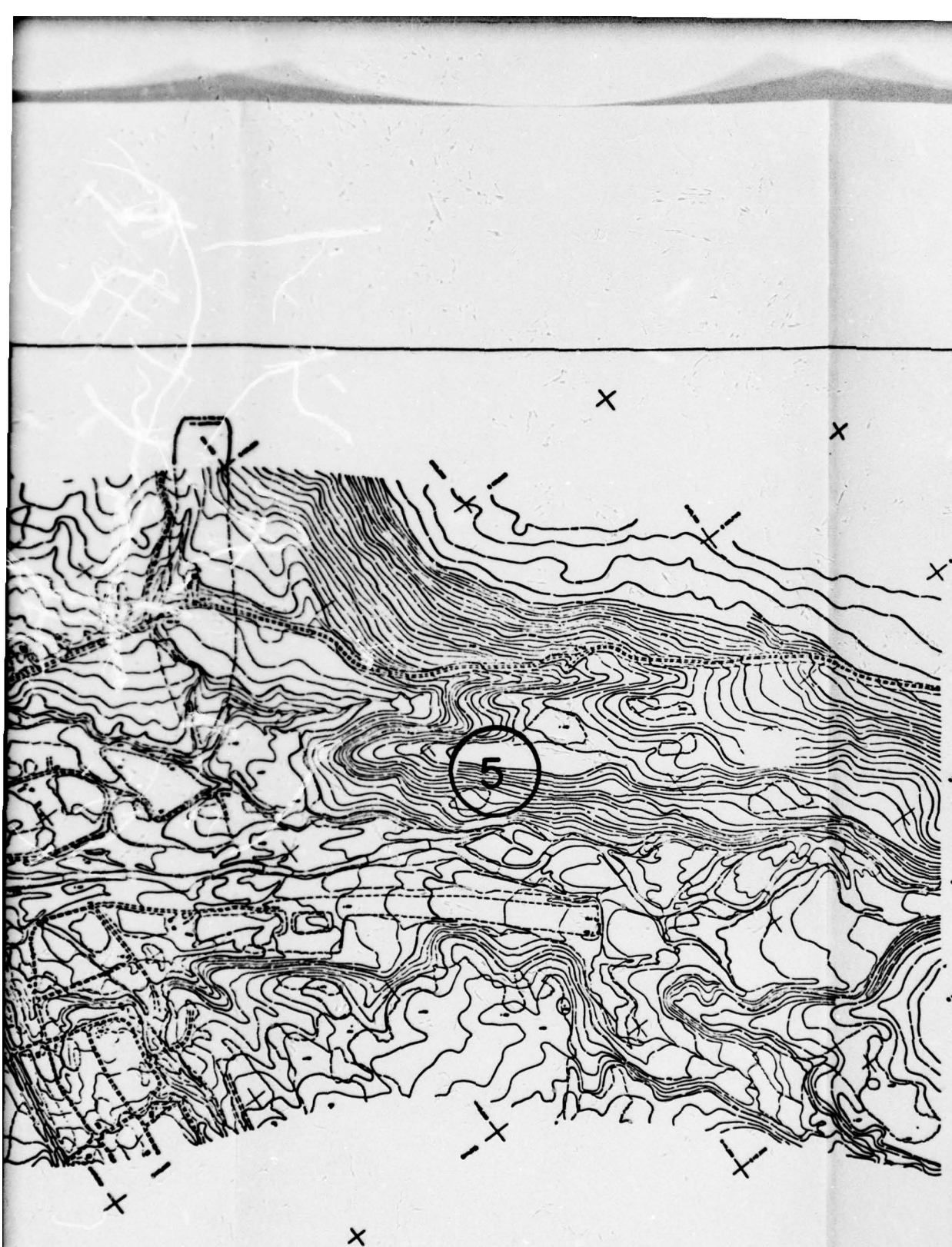


LEGEND

(4) PLATE NUMBER

GLACIER CREEK, ALASKA
INDEX MAP
FLOOD PLAIN INFORMATION STUDY

U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS

PLATE 2 JULY 69

CORPS OF ENGINEERS

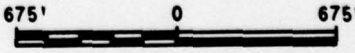
U. S. ARMY

LEGEND

INTERMEDIATE REGIONAL FLOOD

STANDARD PROJECT FLOOD

LIMITS OF OVERFLOW INDICATED MAY VARY SOME FROM ACTUAL LOCATIONS ON GROUND, AS EXPLAINED IN THE REPORT.



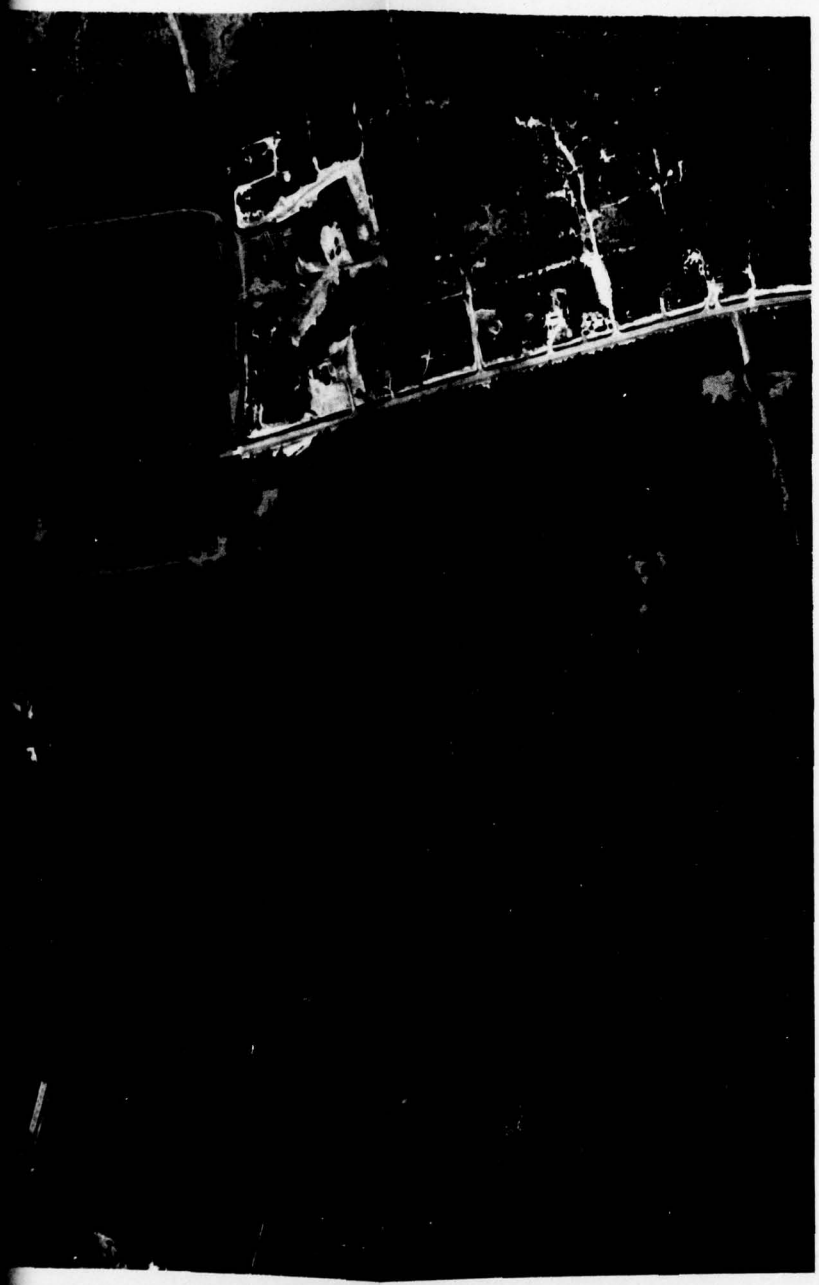
GLACIER CREEK, GIRDWOOD, ALASKA

FLOOD PLAIN INFORMATION STUDY

U.S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS

PLATE 3

AUG., 1969



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INTERMEDIATE REGIONAL FLOOD

STANDARD PROJECT FLOOD

DUE TO DISTORTION IN THE UNCONTROLLED PHOTOGRAPHS THIS PLATE SHOULD NOT BE USED FOR DETAILED MEASUREMENTS AND ARE INCLUDED FOR INFORMATION PURPOSES ONLY.

LIMITS OF OVERFLOW INDICATED MAY VARY SOME FROM ACTUAL LOCATIONS ON GROUND, AS EXPLAINED IN THE REPORT.

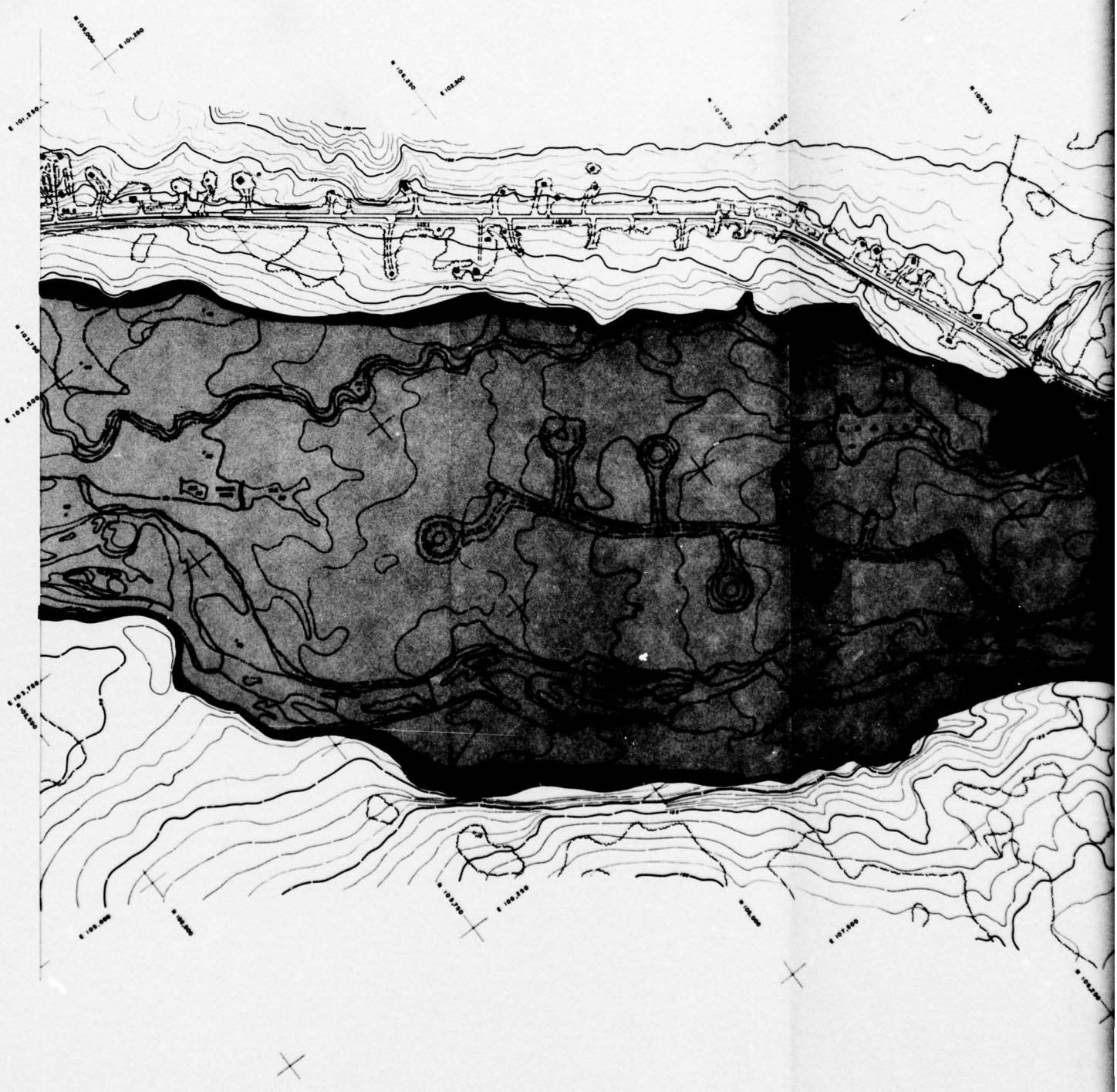
675' 0 675'

GLACIER CREEK, GIRDWOOD, ALASKA

FLOOD PLAIN INFORMATION STUDY

U.S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS

PLATE 3A AUG., 1969


N 104,000
E 101,250
N 106,250
E 102,500
N 107,500
E 103,750
N 108,750
E 101,250
N 103,750
E 103,500
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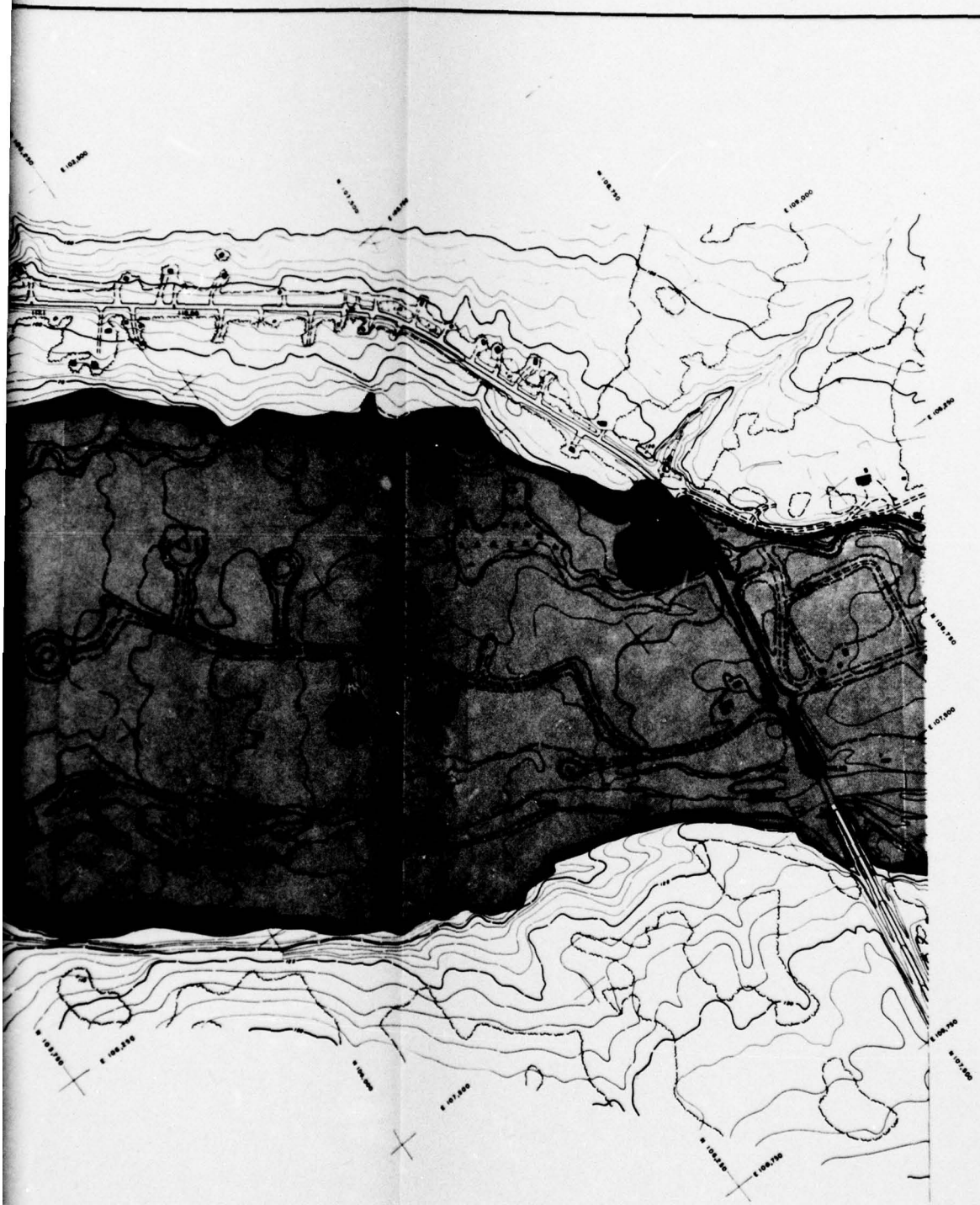
E 105,500
E 105,000
N 106,500
N 103,750
E 100,250
N 106,000
E 107,500
N 108,500



LEGEND

INTERMEDIATE REGIONAL FLOOD

STANDARD PROJECT FLOOD

LIMITS OF OVERFLOW INDICATED MAY VARY SOME FROM ACTUAL LOCATIONS ON GROUND, AS EXPLAINED IN THE REPORT.

675' 0 675'

43

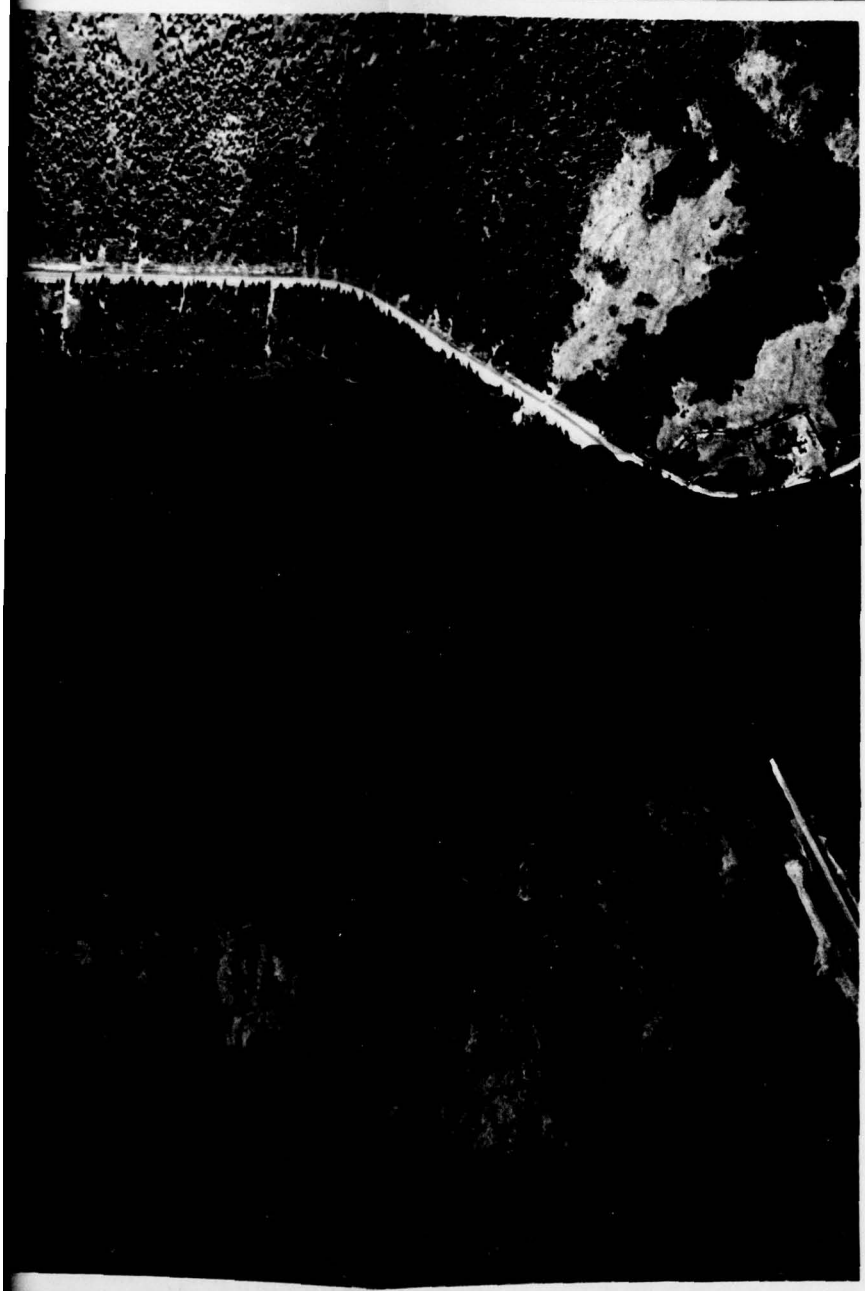
GLACIER CREEK, GIRDWOOD, ALASKA

FLOOD PLAIN INFORMATION STUDY

U.S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS

PLATE 4

AUG., 1969



LEGEND

INTERMEDIATE REGIONAL FLOOD

STANDARD PROJECT FLOOD

DUE TO DISTORTION IN THE UNCONTROLLED PHOTOGRAPHS THIS PLATE SHOULD NOT BE USED FOR DETAILED MEASUREMENTS AND ARE INCLUDED FOR INFORMATION PURPOSES ONLY.

LIMITS OF OVERFLOW INDICATED MAY VARY SOME FROM ACTUAL LOCATIONS ON GROUND, AS EXPLAINED IN THE REPORT.

675' 0 675'

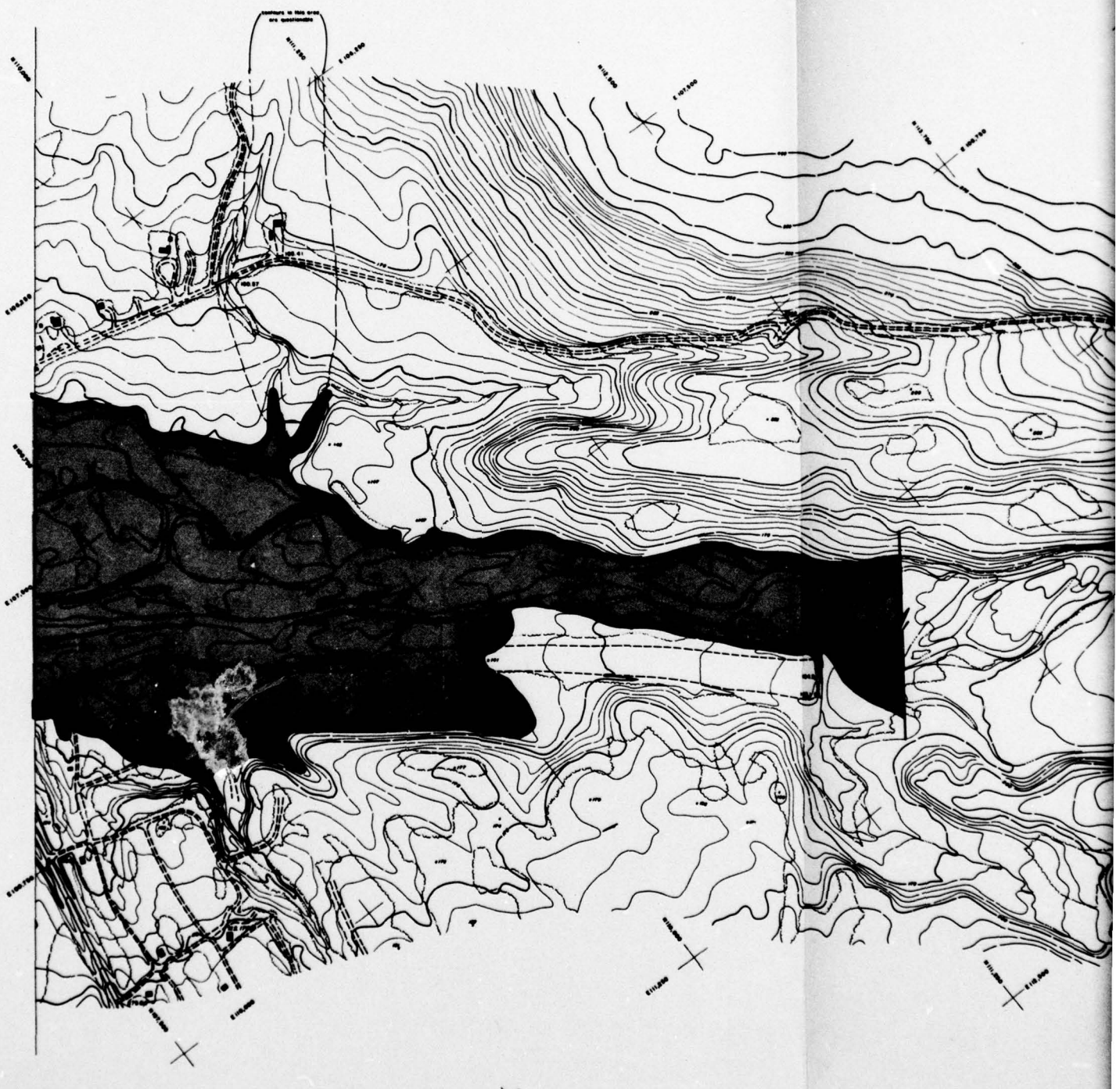
GLACIER CREEK, GIRDWOOD, ALASKA

FLOOD PLAIN INFORMATION STUDY

U.S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS

PLATE 4A

AUG., 1968



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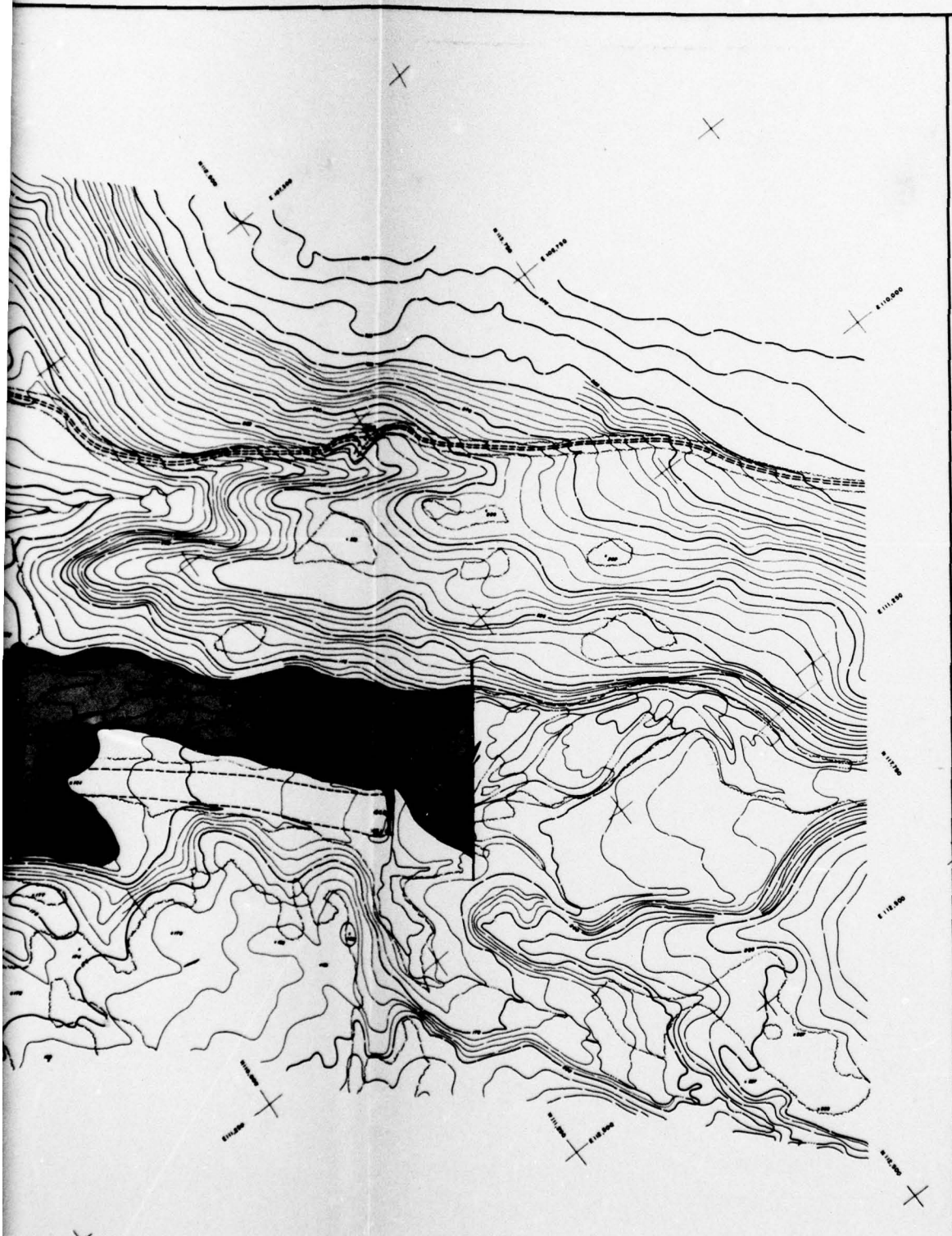
U. S. ARMY



LEGEND

INTERMEDIATE REGIONAL FLOOD

STANDARD PROJECT FLOOD

LIMITS OF OVERFLOW INDICATED MAY VARY SOME FROM ACTUAL LOCATIONS ON GROUND, AS EXPLAINED IN THE REPORT.

675' 0 675'

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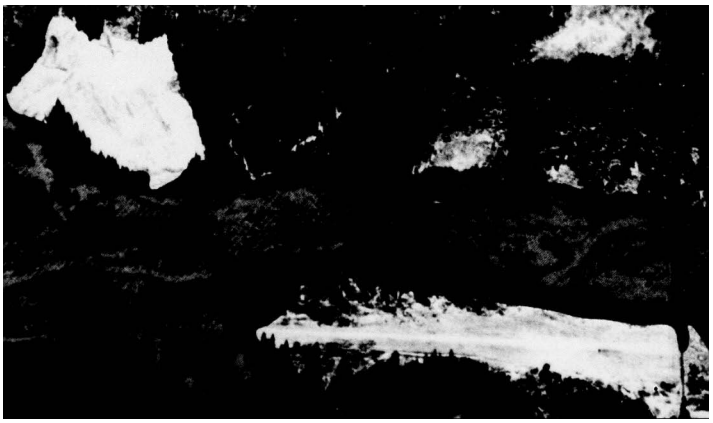
GLACIER CREEK, GIRDWOOD, ALASKA

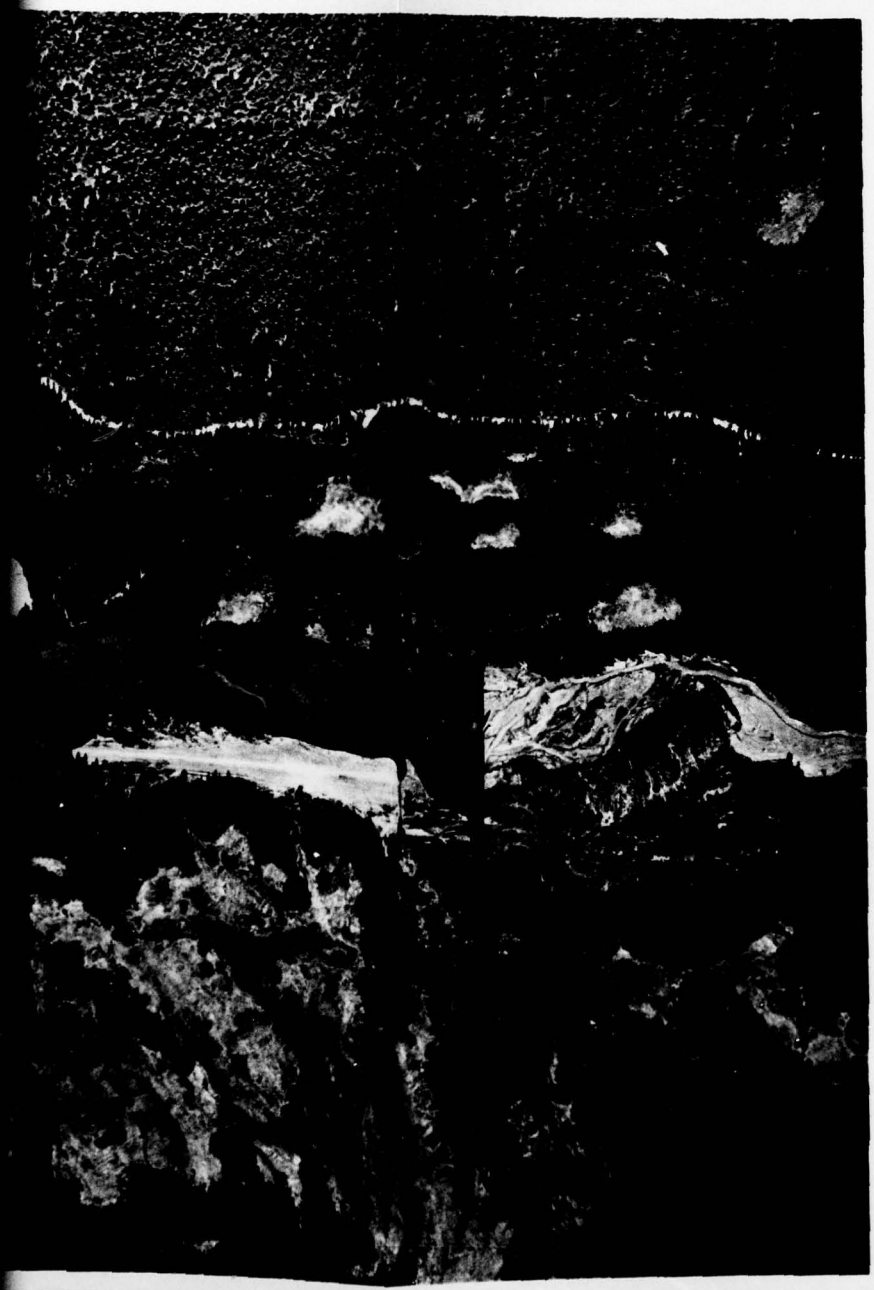
FLOOD PLAIN INFORMATION STUDY

U.S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS

PLATE 5

AUG., 1969





LEGEND

INTERMEDIATE REGIONAL FLOOD

STANDARD PROJECT FLOOD

DUE TO DISTORTION IN THE UNCONTROLLED PHOTOGRAPHS THIS PLATE SHOULD NOT BE USED FOR DETAILED MEASUREMENTS AND ARE INCLUDED FOR INFORMATION PURPOSES ONLY.

LIMITS OF OVERFLOW INDICATED MAY VARY SOME FROM ACTUAL LOCATIONS ON GROUND, AS EXPLAINED IN THE REPORT.

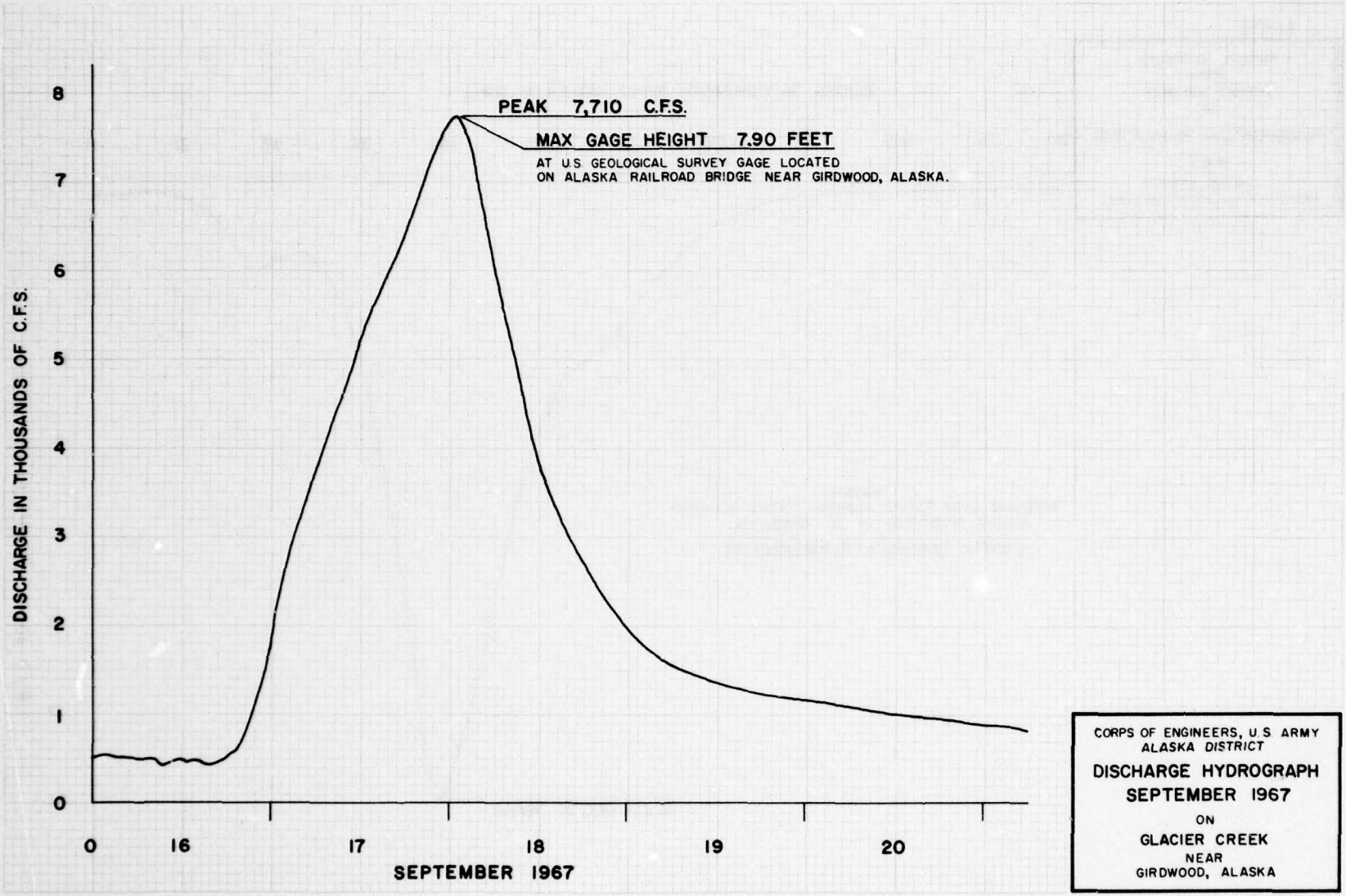
675' 0 675'

GLACIER CREEK, GIRDWOOD, ALASKA

FLOOD PLAIN INFORMATION STUDY

U.S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS

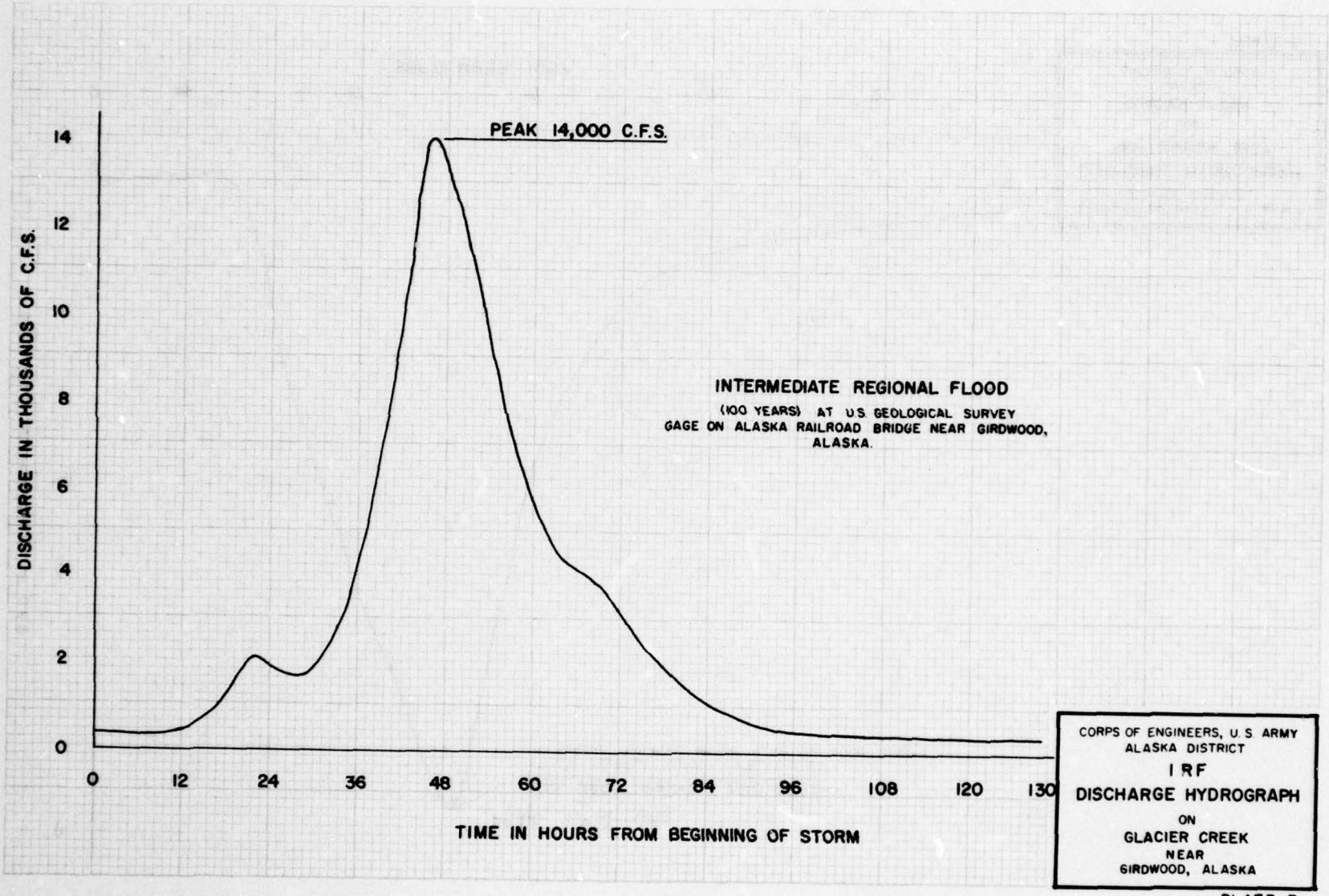
PLATE 5A AUG., 1969



CORPS OF ENGINEERS, U.S. ARMY
ALASKA *DISTRICT*

DISCHARGE HYDROGRAPH
SEPTEMBER 1967
ON
GLACIER CREEK
NEAR
GIRDWOOD, ALASKA

PLATE 6



CORPS OF ENGINEERS, U.S. ARMY
ALASKA DISTRICT

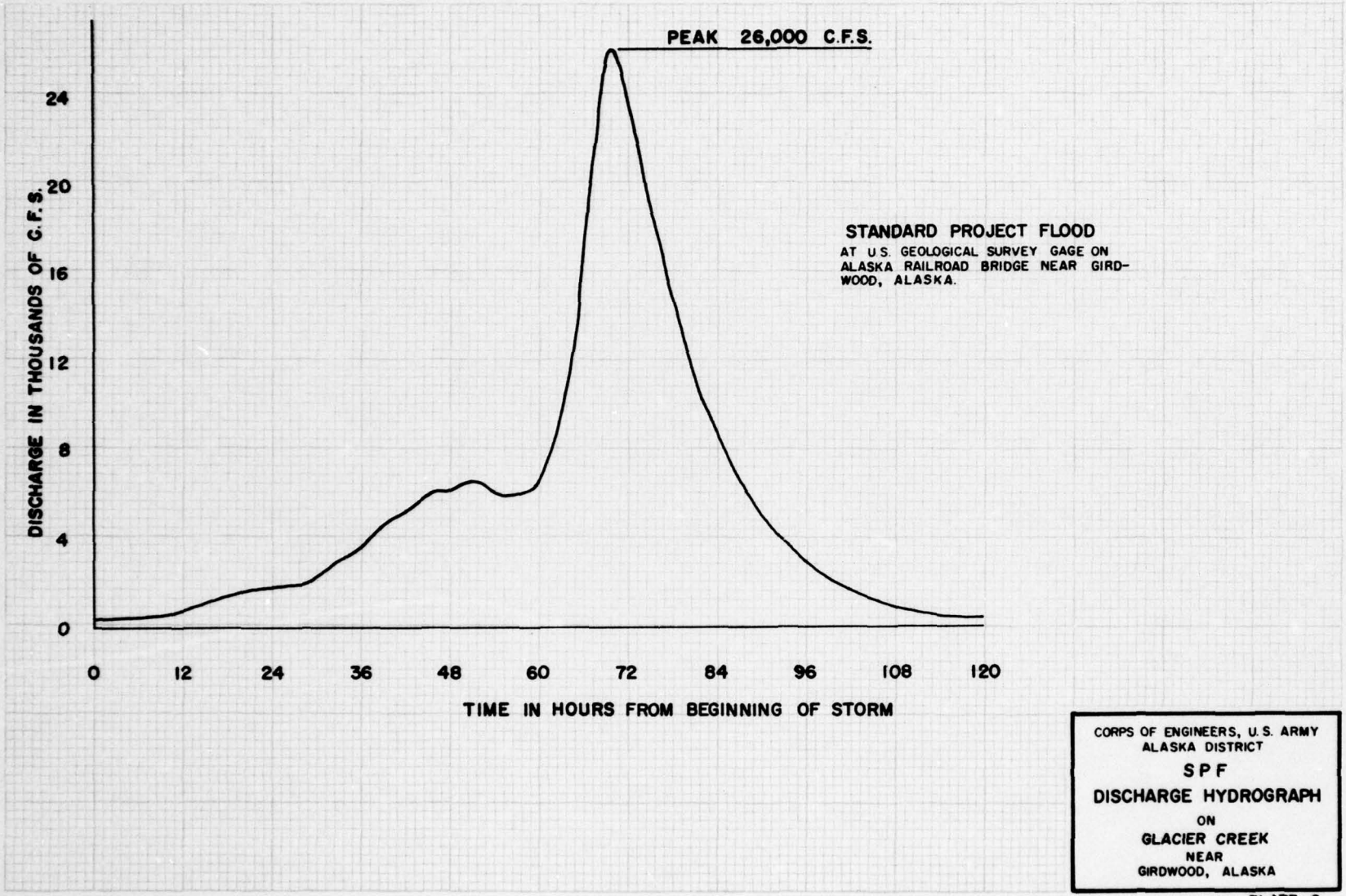
I RF

DISCHARGE HYDROGRAPH

ON

GLACIER CREEK
NEAR
GIRDWOOD, ALASKA

PLATE 7



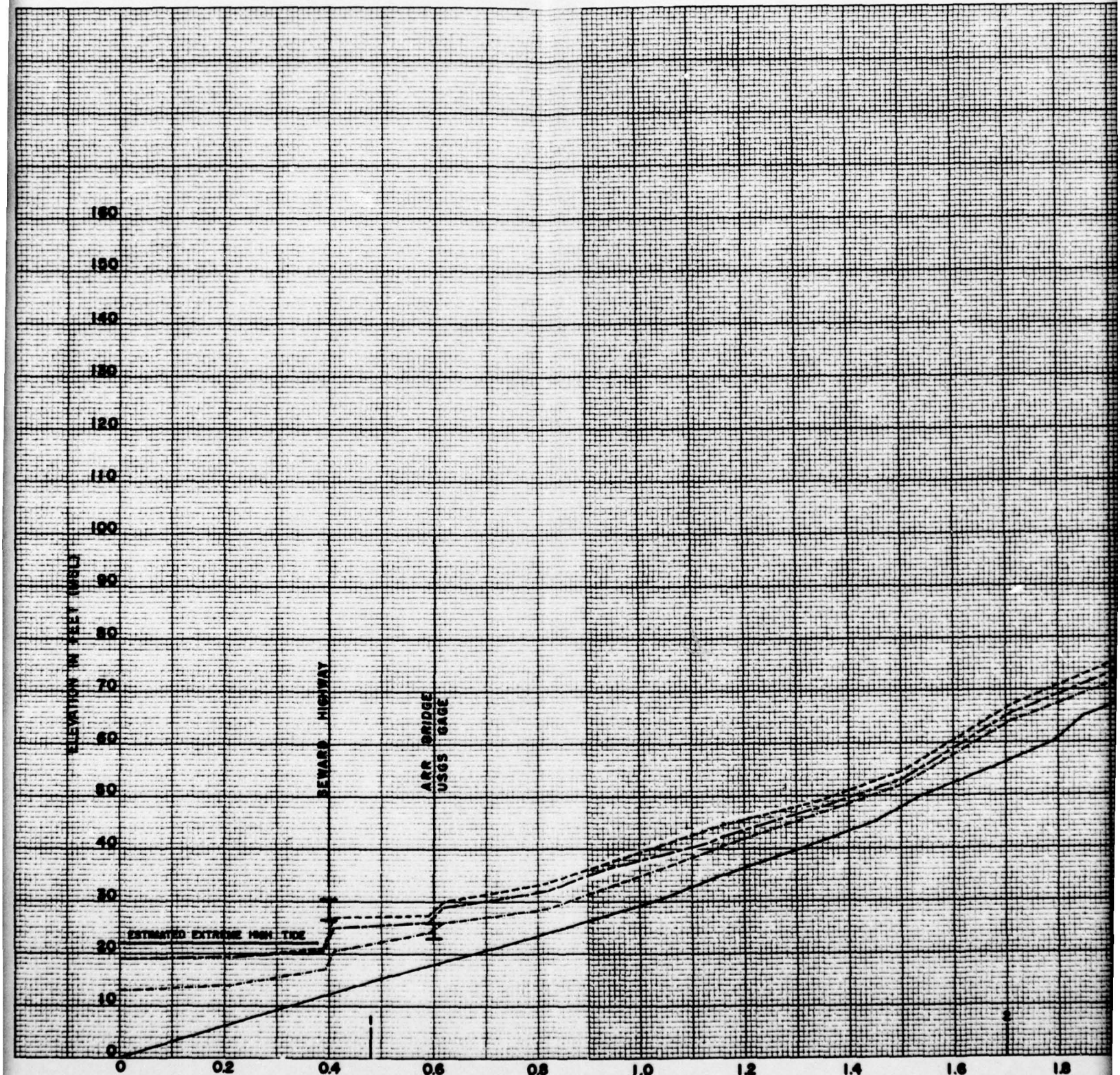
STANDARD PROJECT FLOOD
AT U.S. GEOLOGICAL SURVEY GAGE ON ALASKA RAILROAD BRIDGE NEAR GIRDWOOD, ALASKA.

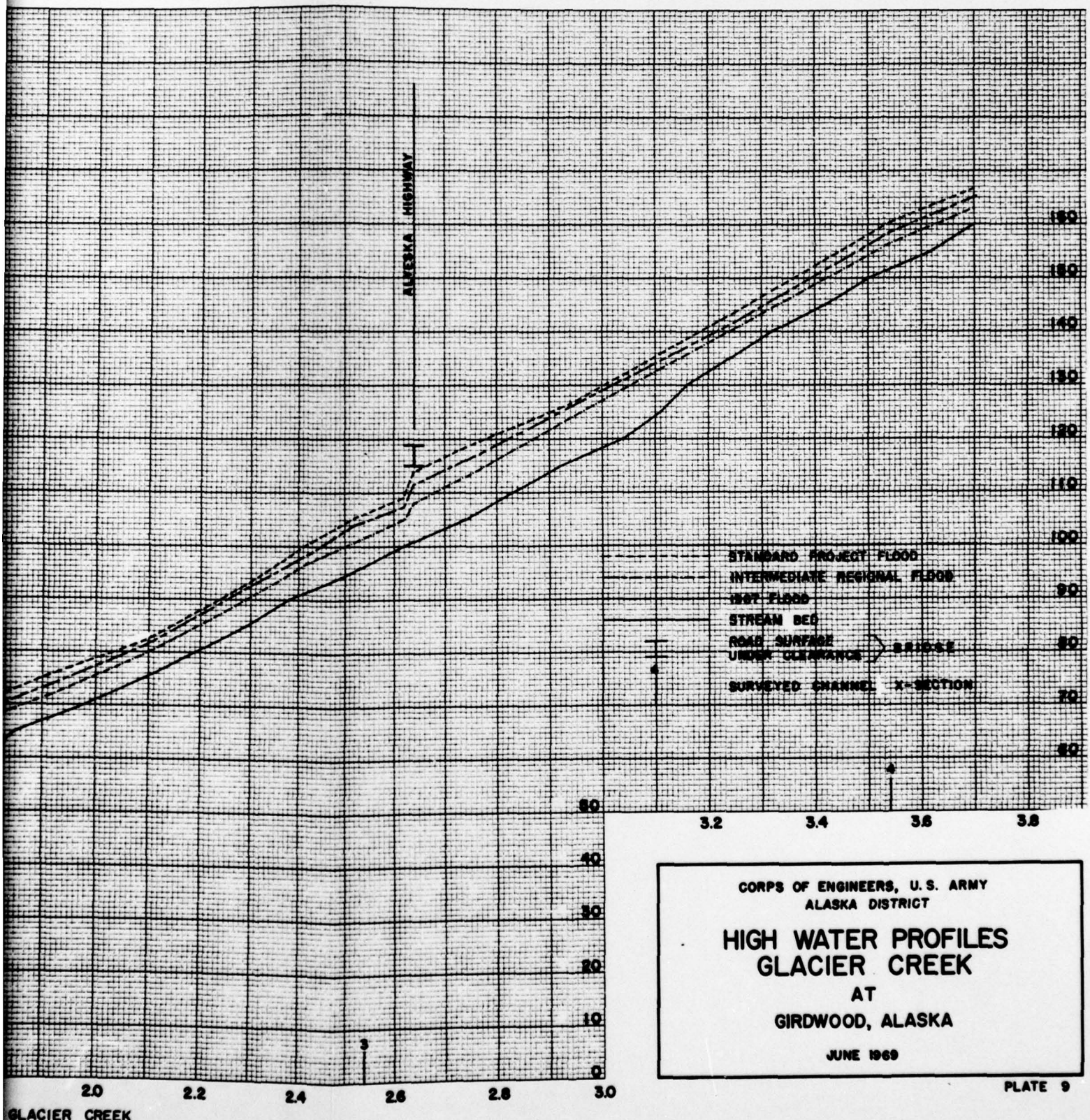
CORPS OF ENGINEERS, U.S. ARMY
ALASKA DISTRICT

SPF

DISCHARGE HYDROGRAPH
ON
GLACIER CREEK
NEAR
GIRDWOOD, ALASKA

PLATE 8


ELEVATION IN FEET (MSL)
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
MILES ABOVE MOUTH OF GL
SEWARD HIGHWAY
ARR BRIDGE
USGS GAGE
ESTIMATED EXTREME HIGH TIDE



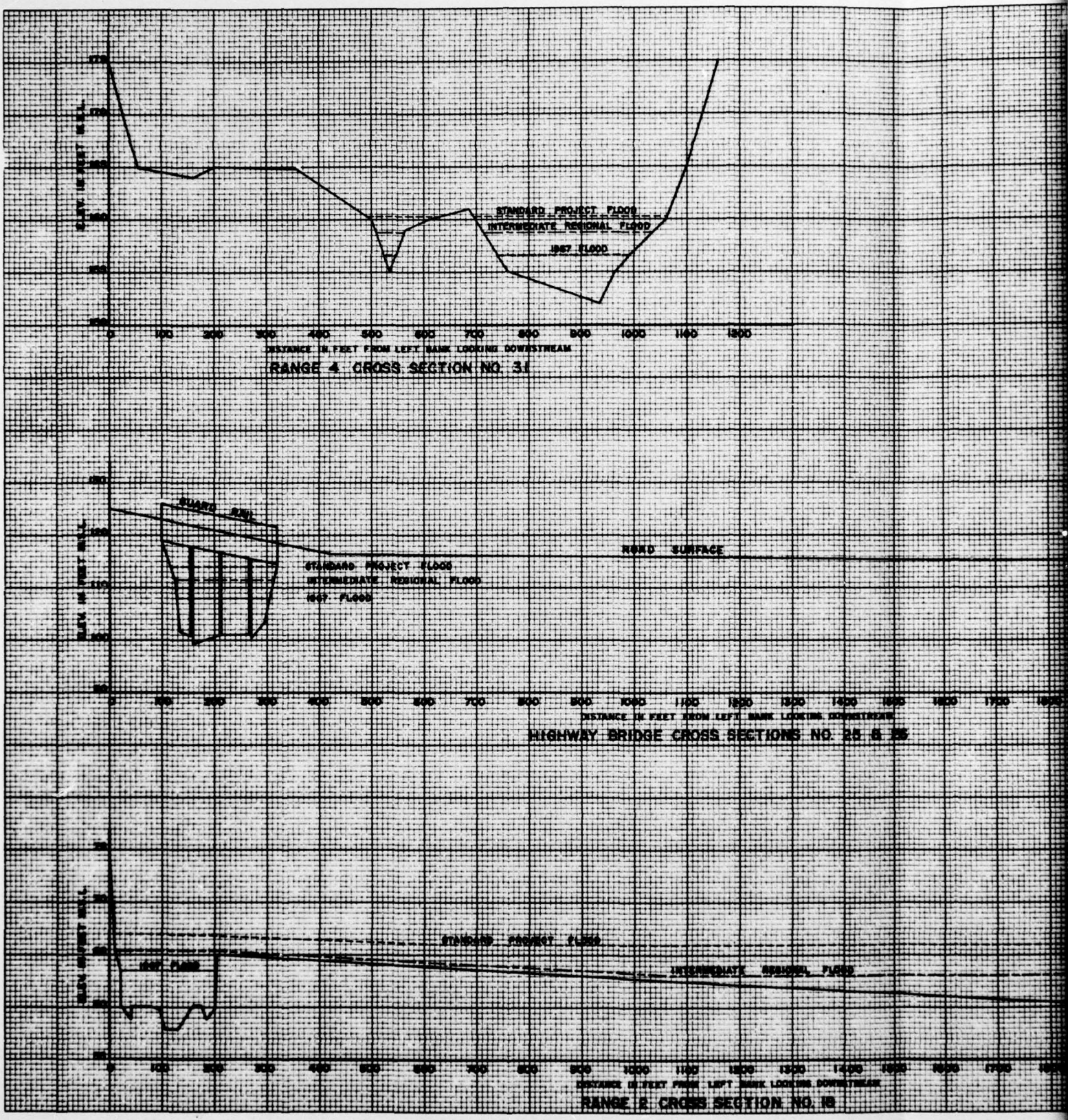
CORPS OF ENGINEERS, U. S. ARMY
ALASKA DISTRICT

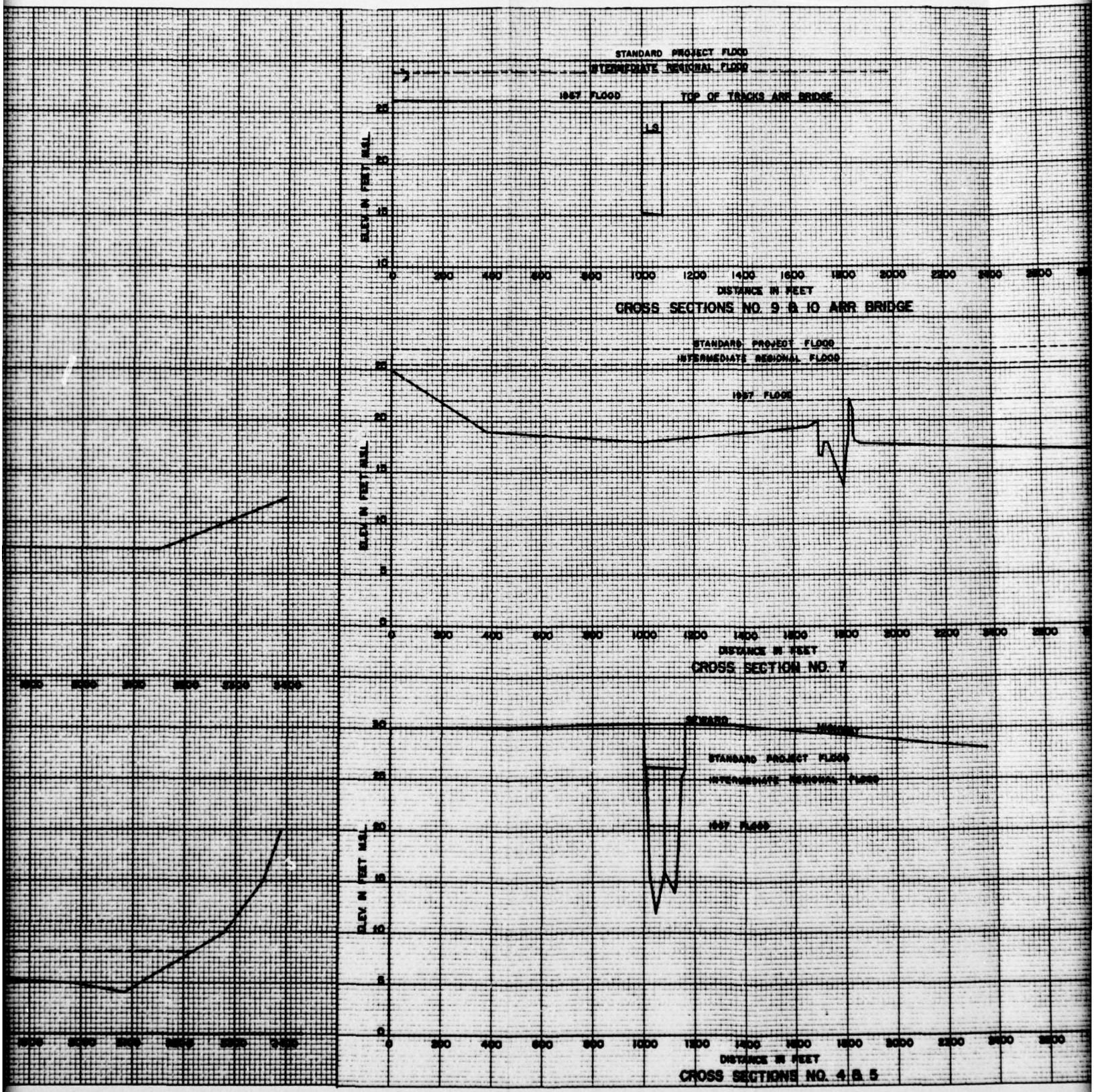
HIGH WATER PROFILES
GLACIER CREEK
AT
GIRDWOOD, ALASKA

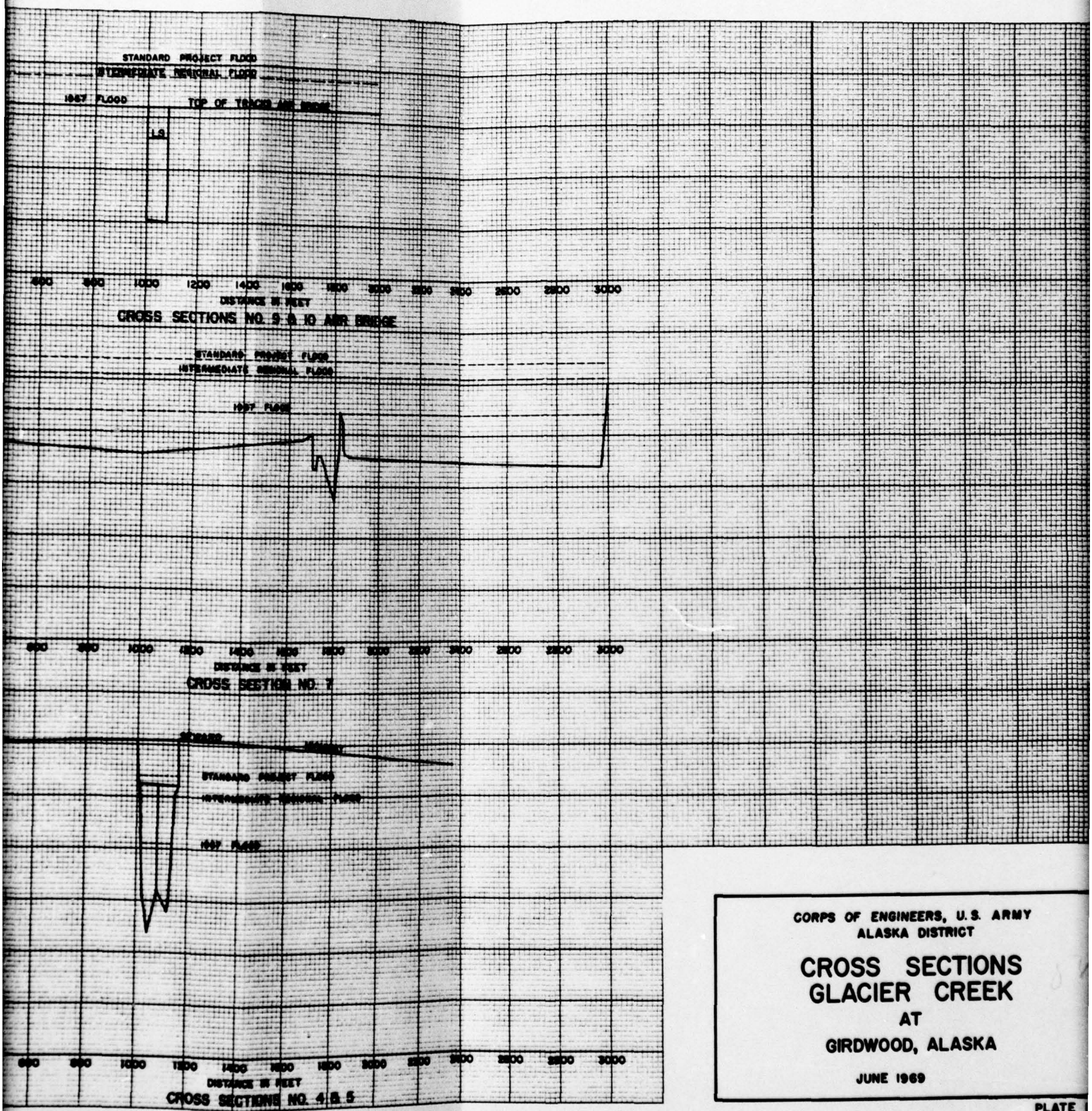
JUNE 1969

PLATE 9

2


STANDARD PROJECT FLOOD
INTERMEDIATE REGIONAL FLOOD
1967 FLOOD
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
DISTANCE IN FEET FROM LEFT BANK LOOKING DOWNSTREAM
RANGE 4 CROSS SECTION NO. 31
GUARD RAIL
ROAD SURFACE
STANDARD PROJECT FLOOD
INTERMEDIATE REGIONAL FLOOD
1967 FLOOD
DISTANCE IN FEET FROM LEFT BANK LOOKING DOWNSTREAM
HIGHWAY BRIDGE CROSS SECTIONS NO. 25 & 26
STANDARD PROJECT FLOOD
1967 FLOOD
INTERMEDIATE REGIONAL FLOOD
DISTANCE IN FEET FROM LEFT BANK LOOKING DOWNSTREAM
RANGE 2 CROSS SECTION NO. 18


STANDARD PROJECT FLOOD
INTERMEDIATE REGIONAL FLOOD
1957 FLOOD
TOP OF TRACKS ARR BRIDGE
1.9
ELEV IN FEET MSL
DISTANCE IN FEET
CROSS SECTIONS NO. 9 & 10 ARR BRIDGE
STANDARD PROJECT FLOOD
INTERMEDIATE REGIONAL FLOOD
1957 FLOOD
ELEV IN FEET MSL
DISTANCE IN FEET
CROSS SECTION NO. 7
SEWARD
HIGHWAY
STANDARD PROJECT FLOOD
INTERMEDIATE REGIONAL FLOOD
1957 FLOOD
ELEV IN FEET MSL
DISTANCE IN FEET
CROSS SECTIONS NO. 4 & 5



CORPS OF ENGINEERS, U.S. ARMY
ALASKA DISTRICT

CROSS SECTIONS GLACIER CREEK AT GIRDWOOD, ALASKA

JUNE 1969

PLATE